Frames

منشات تستخدم لتغطية بحور من اكثر من ١٢م وتتميز بان لها عمق (depth)

اقل وترخيم اقل (deflection) مقارنة ب (Main girders)

-Types of Frames

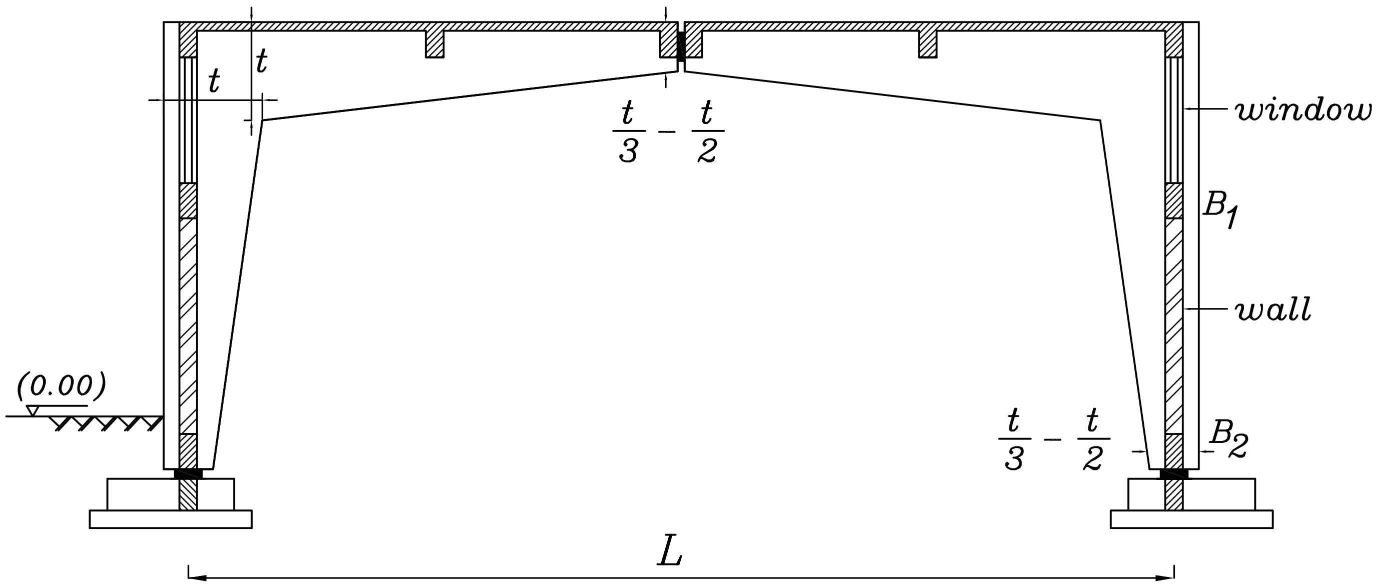
1-Three hinged Frame.

2-Two hinged frame.

3-Fixed Frame.

4-Cantilever Frame.

5-Continuous Frame.



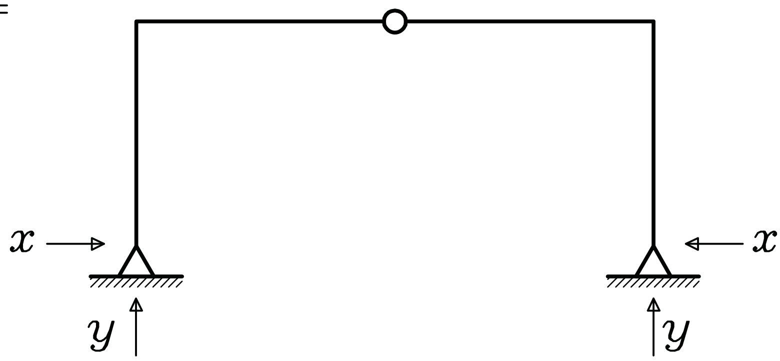
- Three hinged Frame is usually used For spans (12 → 20m)
- It is better for weak soil [determinate structure].

-Concrete Dimensions

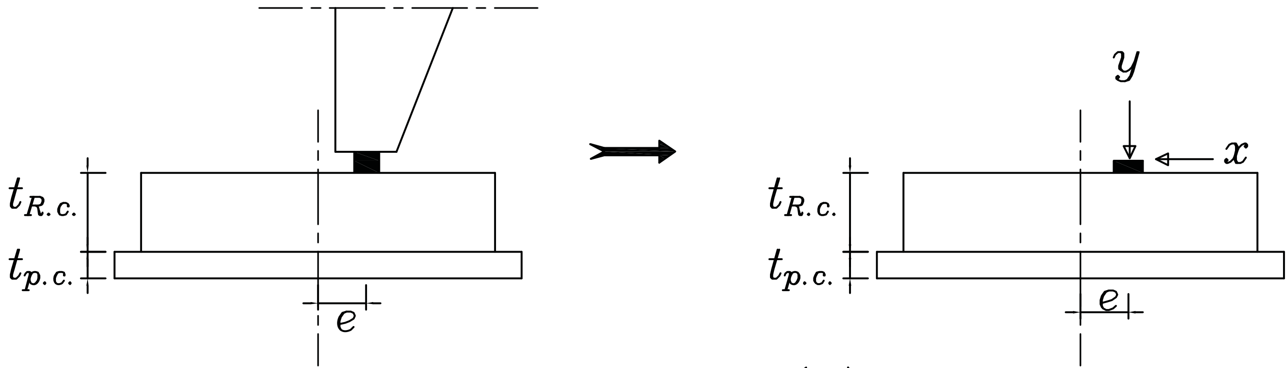
$$\boxed{t = \frac{L}{10}}$$

$$b = \begin{cases} 30\ cm \\ \dfrac{spacing}{20} \end{cases}$$ ايهما اكبر

-Statical System



نقوم بترحيل قواعد(Frame) للخارج مسافة (e) لضمان توزيع الاجهادات بانتظام على التربة (uniform stress)



Moment due to vertical reaction (y) =Moment due to hz Reaction(x)

$$y*e=x(t_{R.c.}+t_{p.c.}) \longrightarrow \boxed{e=\frac{x(t_{R.c.}+t_{p.c.})}{y}}$$

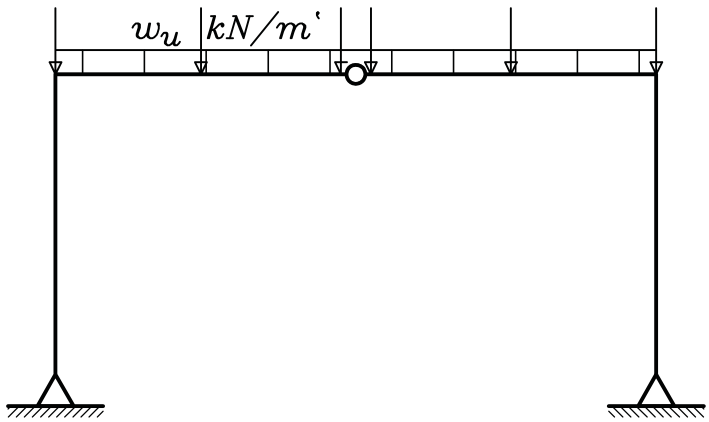
-Steps of design

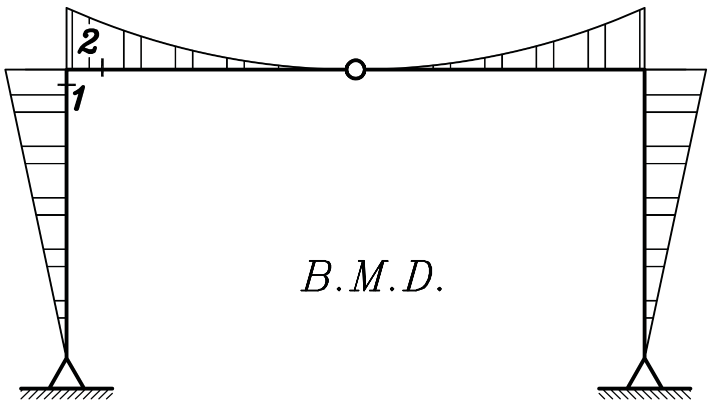
1-Get the loads on Secondary beams from load distribution and get their reactions on the frame.

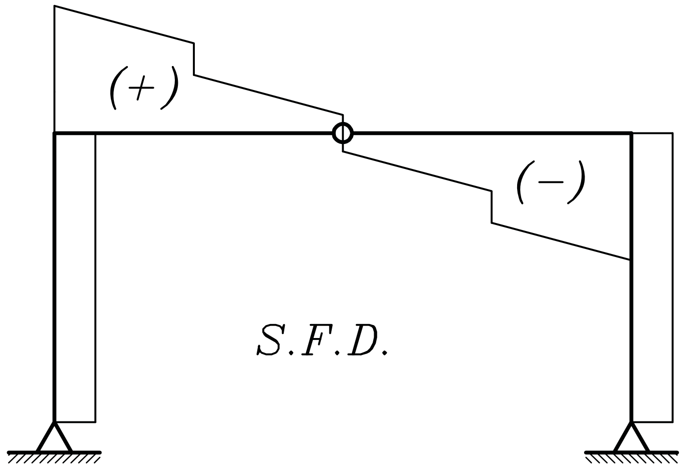
2-Get the distributed loads on the frame.

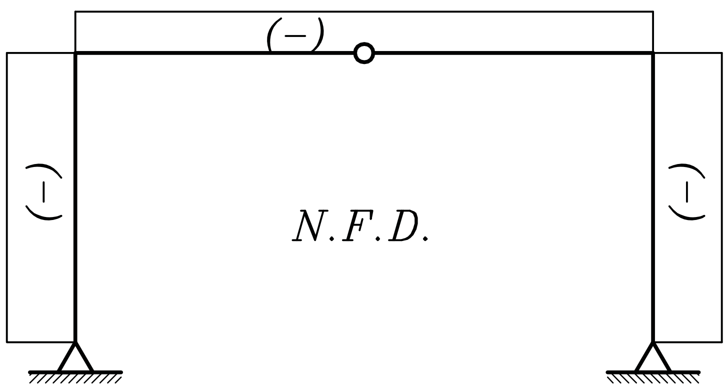
$$\boxed{w=\gamma_c\, b(t-t_s)*1.40+\frac{\Sigma Area}{span}\, w_s}$$

3- Draw B.M.D , N.F.D. , S.F.D. of the Frame







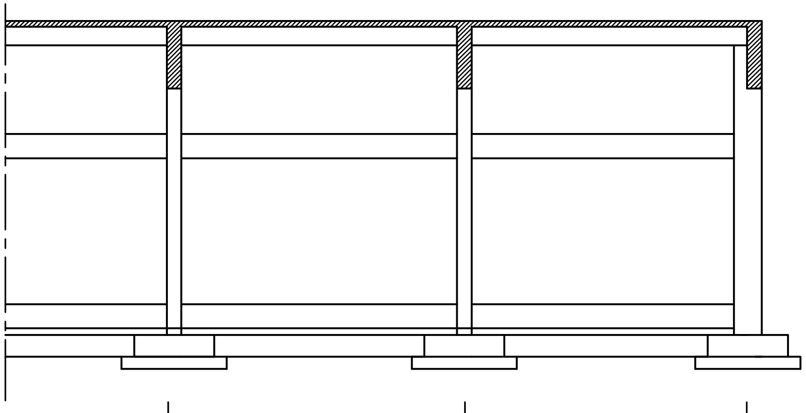


4−Design section (1−1) , (2−2) and get Rft.

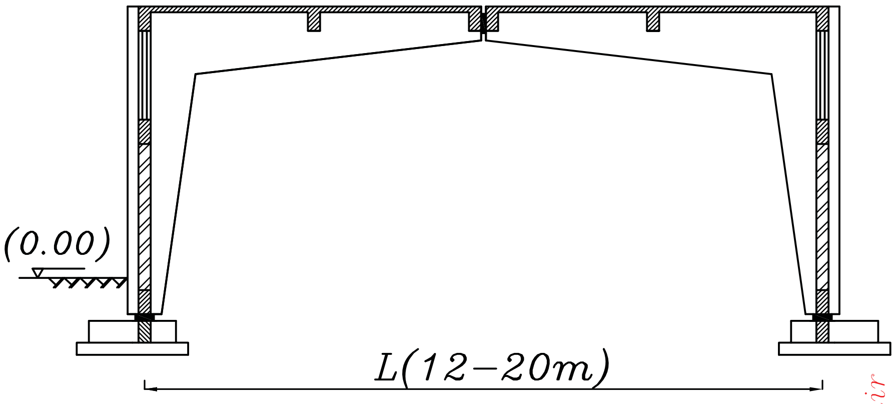
ملحوظة لاحظ ان الكمرات (B_1 ,B_2) فائدتها ما يلى

١ - الكمرة (B_1) تقلل (Buckling length) فى اتجاه (Out side Plan)

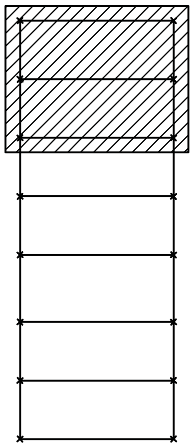
٢ - السملة (B_2) تتحمل الحائط و تقوم بتربيط الـ (frames) ببعضها



Side view

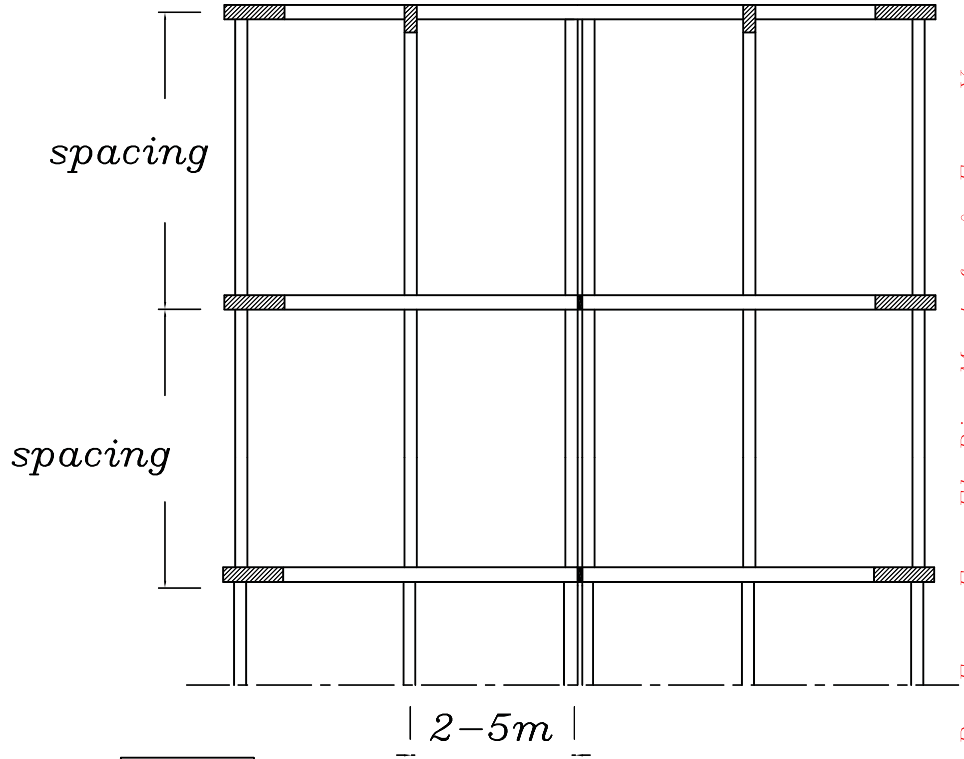


Elevation



KEY PLAN

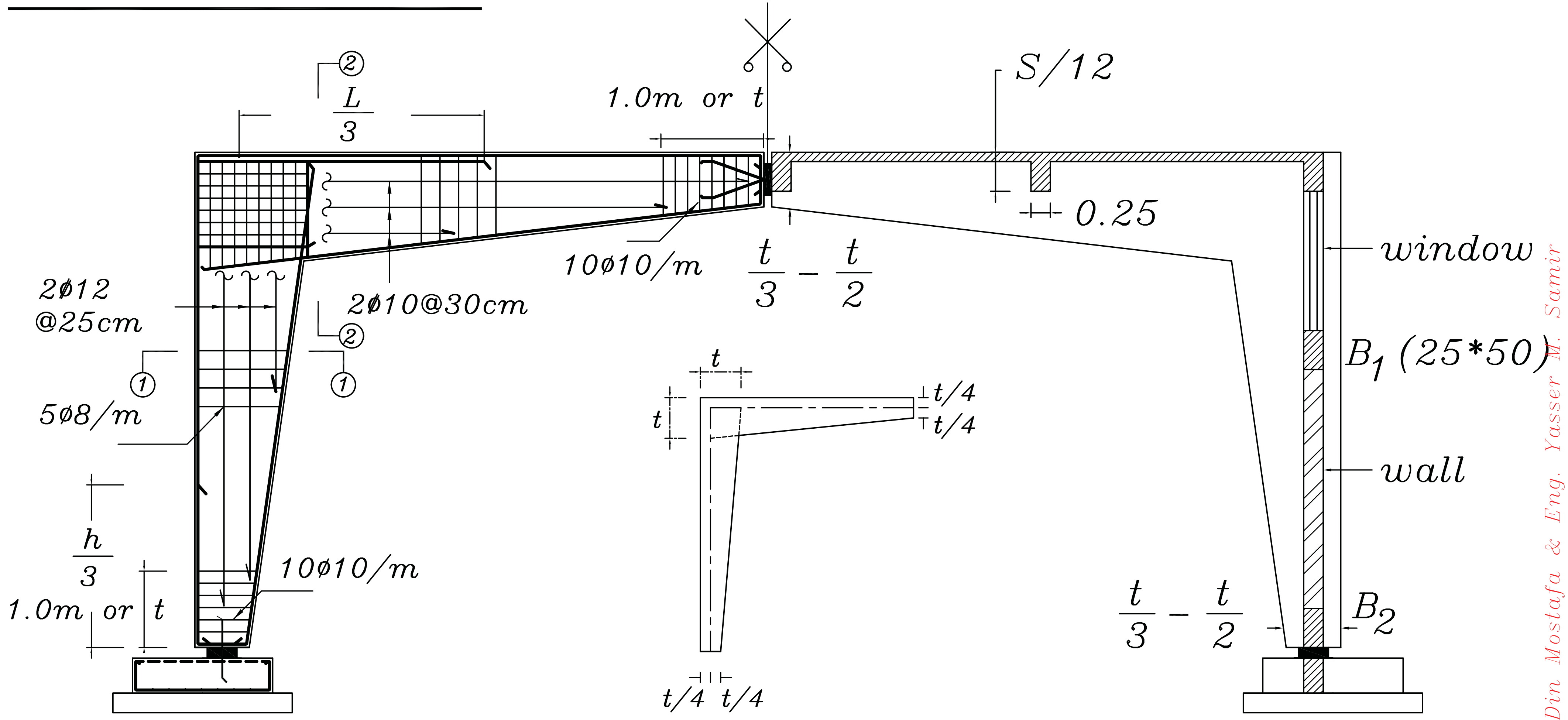
1:200 ⟶ 1:400



Plan

By Eng. Ezz El-Din Mostafa & Eng. Yasser M. Samir

R.F.T. of the Frame



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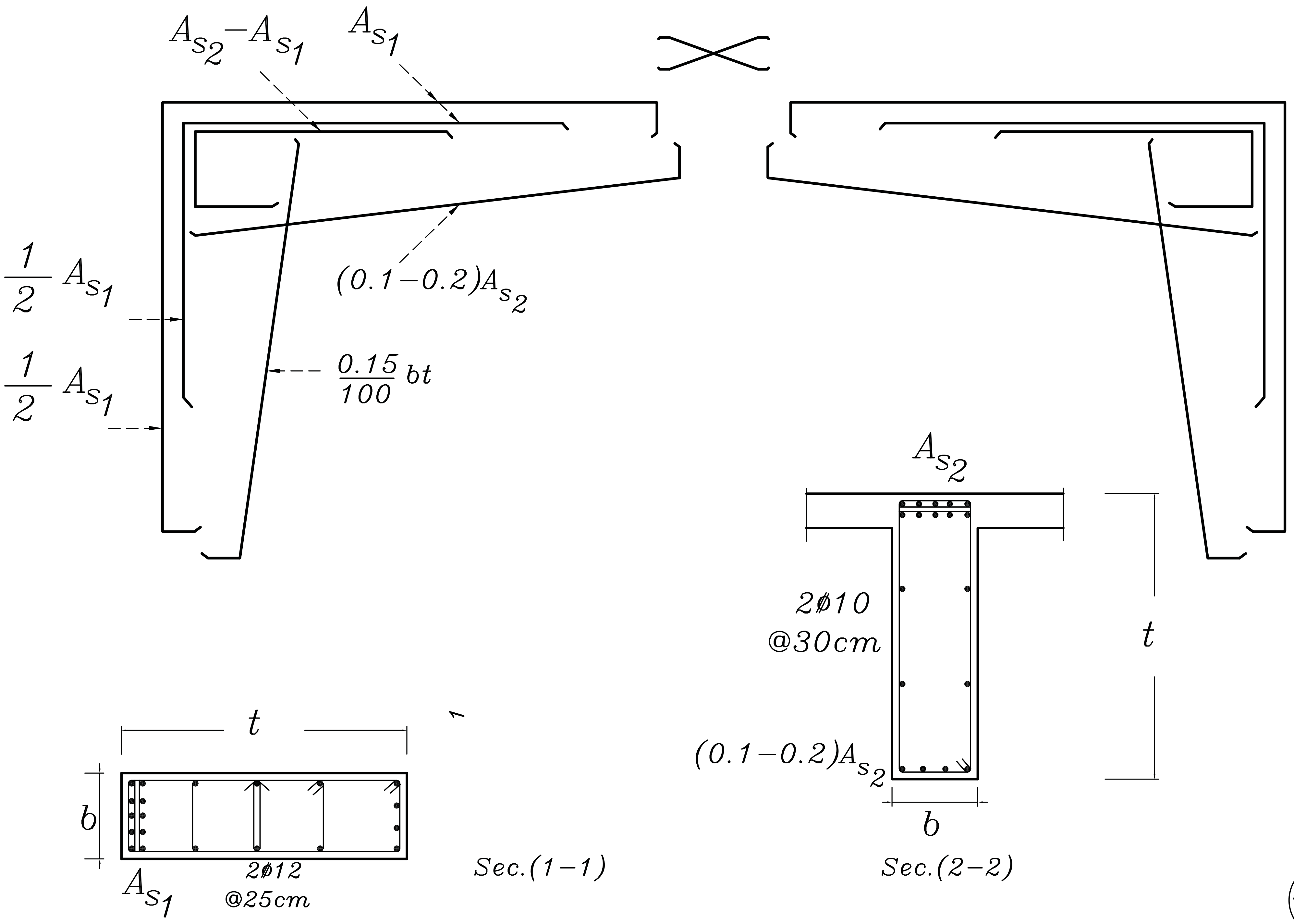
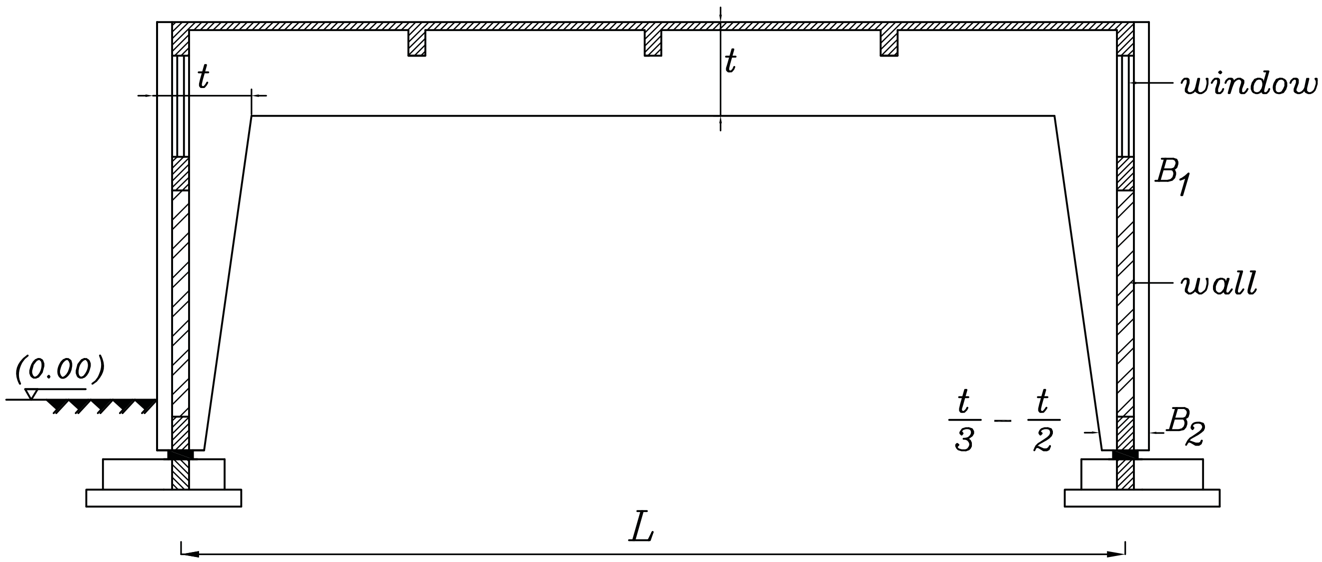


$A_{s_2} - A_{s_1}$
A_{s_1}
$\frac{1}{2} A_{s_1}$
$(0.1-0.2)A_{s_2}$
$\frac{1}{2} A_{s_1}$
$\frac{0.15}{100}\,bt$
A_{s_2}
2ϕ10
@30cm
t
$(0.1-0.2)A_{s_2}$
b
t
1
b
A_{s_1}
2ϕ12
@25cm
Sec.(1-1)
Sec.(2-2)

Two Hinged Frame



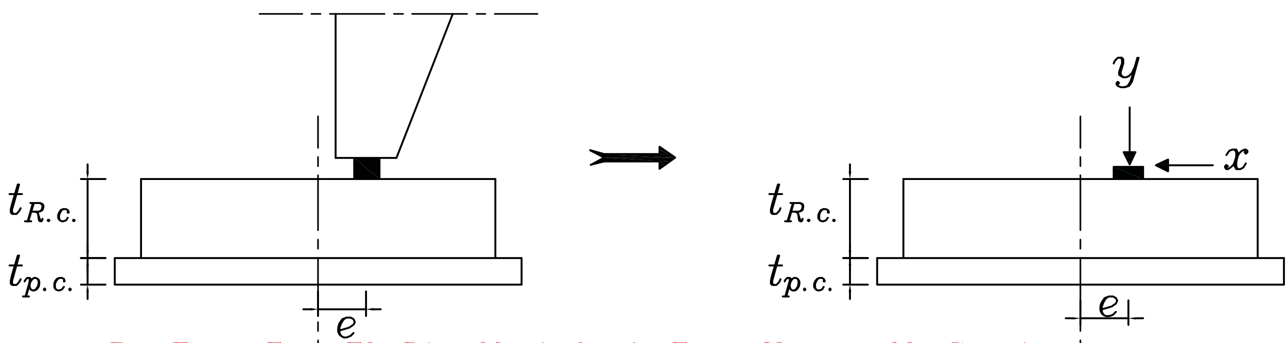
– *Two Hinged Frame is used for span (12 → 25)*

–Concrete Dimensions

$$t = \frac{L}{12-14} \qquad b = \begin{cases} 30\ cm \\ \dfrac{spacing}{20} \end{cases}$$ ايها اكبر

–Statical System

نقوم بترحيل قواعد(Frame) للخارج مسافة (e) لضمان توزيع الاجهادات بانتظام على التربة (uniform stress)



Moment due to vertical reaction (y) =Moment due to hz Reactin(x)

$$y*e=x(t_{R.c.}+t_{p.c.}) \longrightarrow \boxed{e=\frac{x(t_{R.c.}+t_{p.c.})}{y}}$$

Steps of design

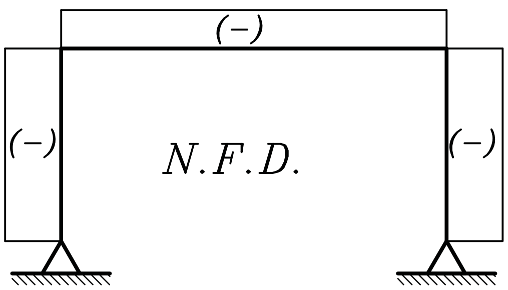
1-Get the loads on the secondary beams from load distribution and get their reactions on the frame.

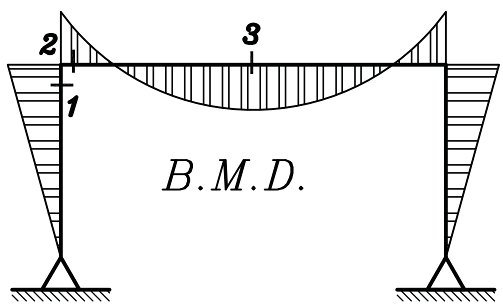
2-Get the distributed load on the frame.

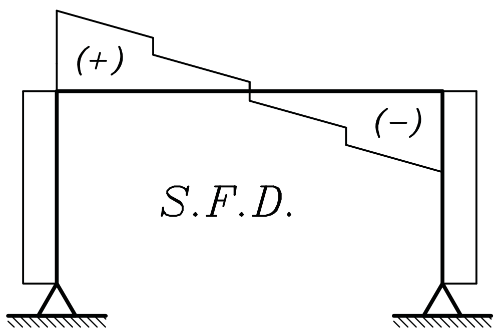
$$\boxed{w_u=\gamma_c\, b(t-t_s)*1.40+\frac{\Sigma Area}{span}\, w_s}$$

3-Solve the frame using virtual work Method OR Moment Distribution Method.

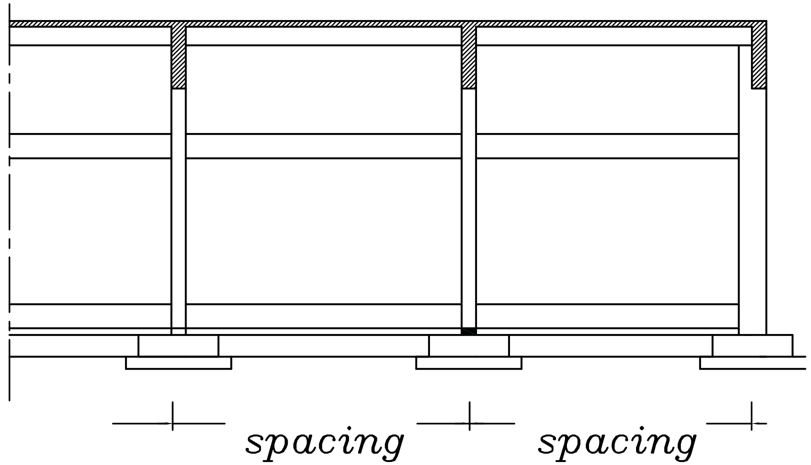
4- Draw B.M.D , N.F.D. , S.F.D.



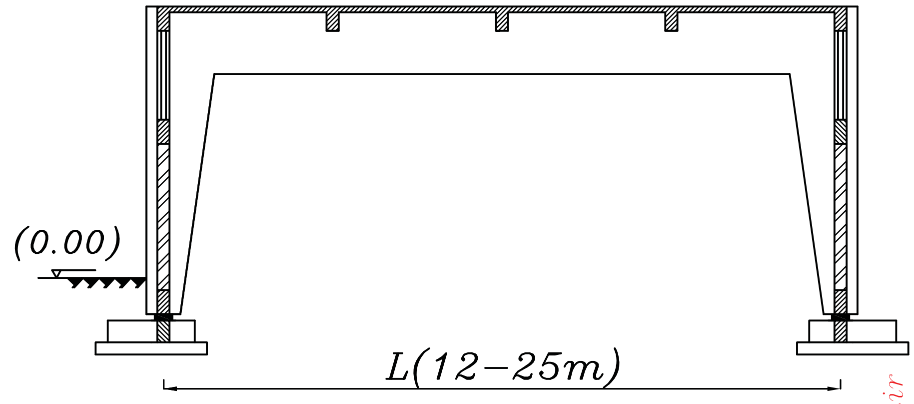




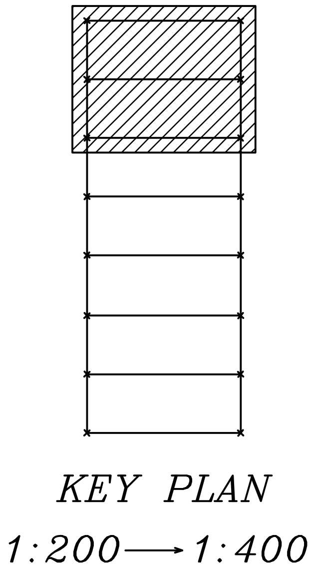
5-Design sections (1-1),(2-2),(3-3) and get rft.

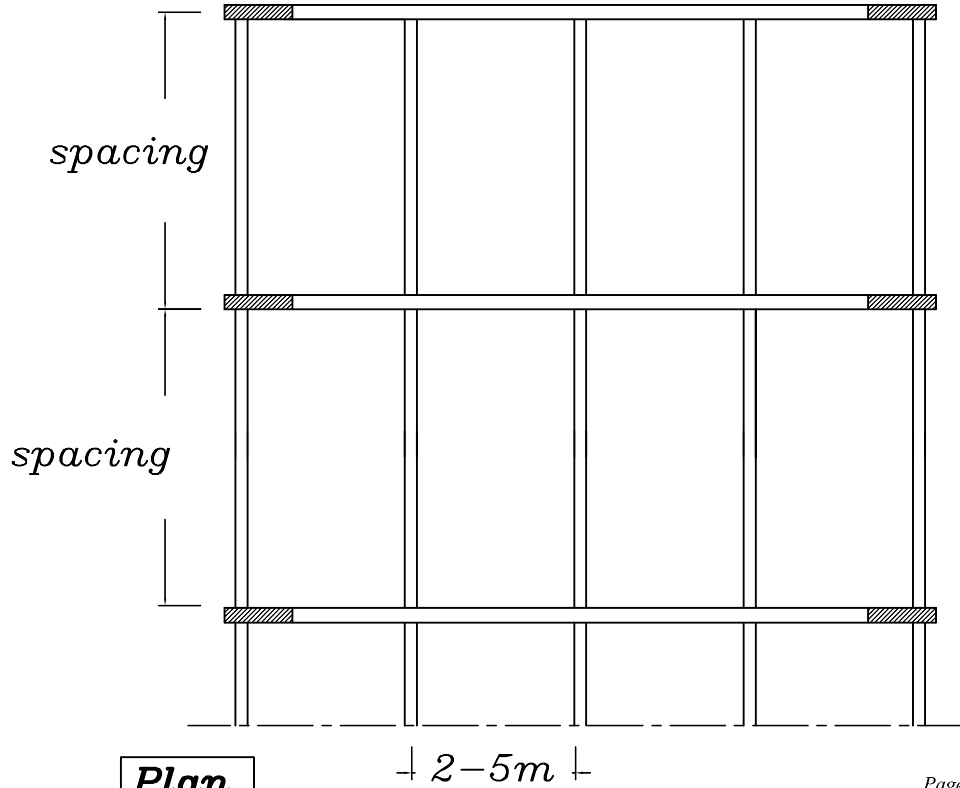


Side view



Elevation





Plan

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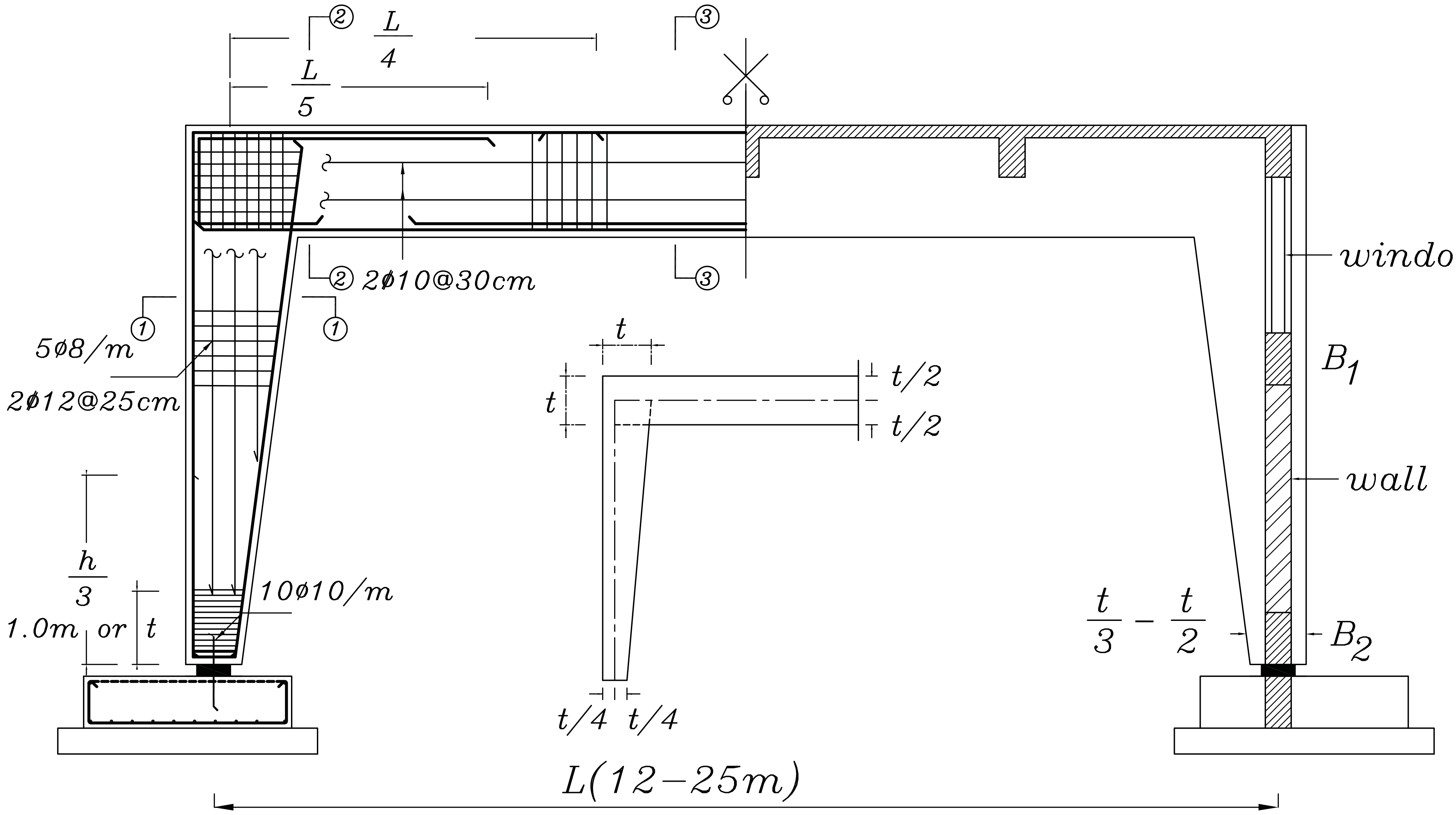
R.F.T. of the Frame



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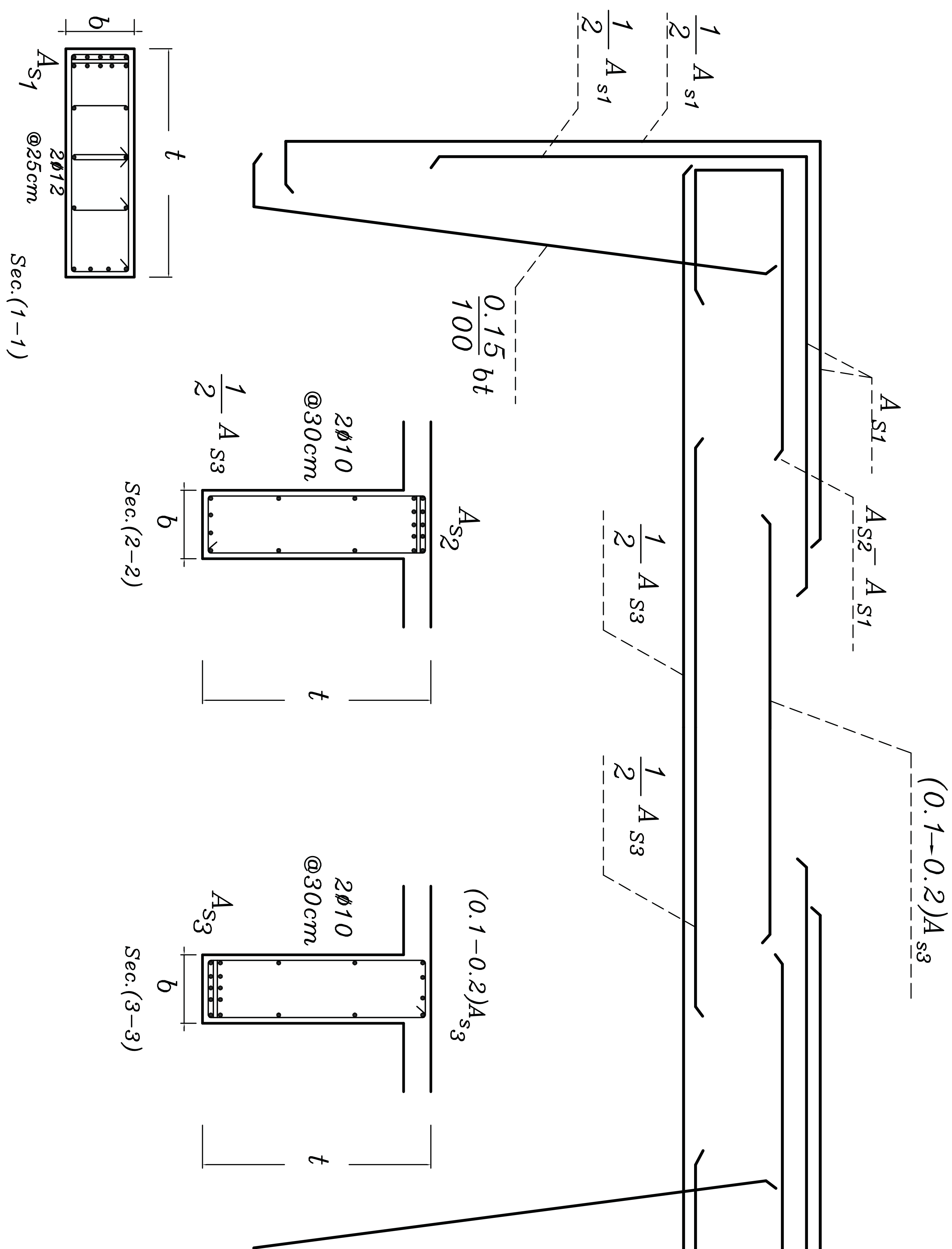

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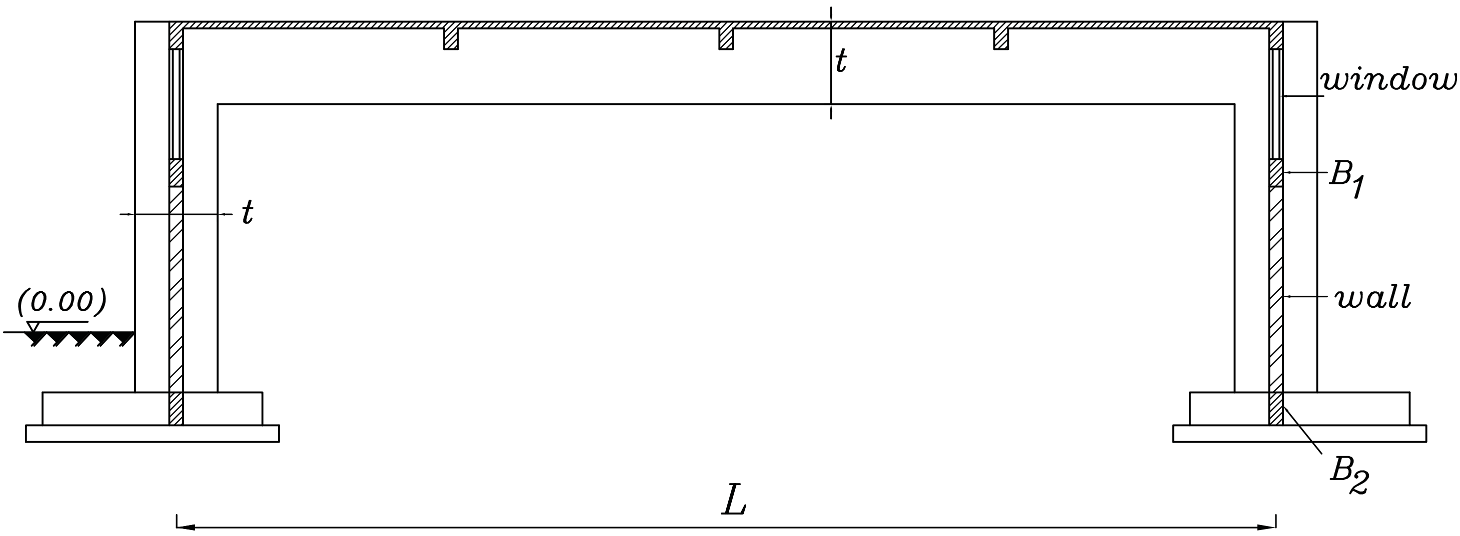
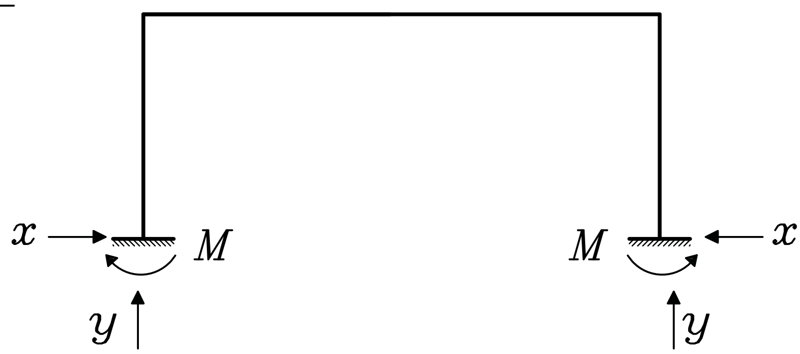
Fixed Frame



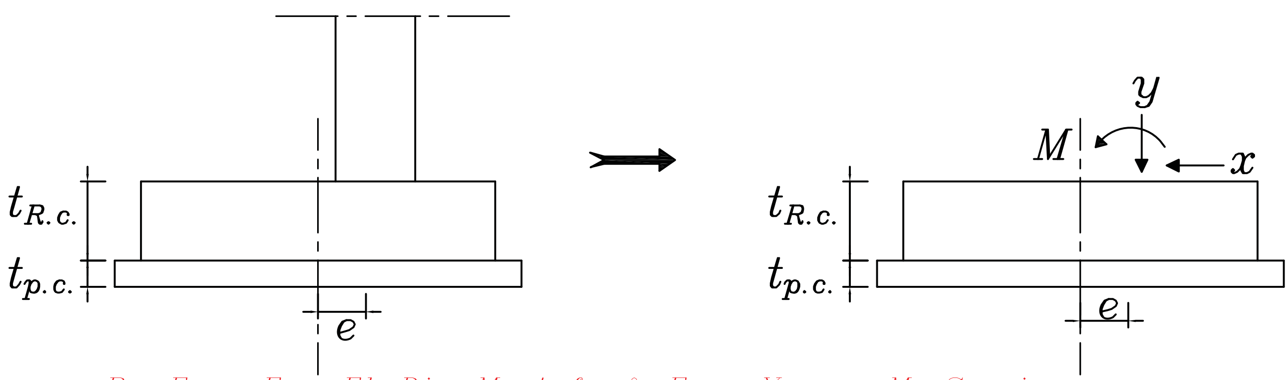
–Concrete Dimensions

$$t = \frac{L}{14-16} \qquad b = \left[\begin{array}{l} 30 \ cm \\ \frac{spacing}{20} \end{array} \right.$$ ايها اكبر

–Statical System



نقوم بترحيل قواعد (Frame) للخارج مسافة (e) لضمان توزيع الاجهادات بانتظام على التربة (uniform stress)



Moment due to vertical reaction (y) =Moment due to hz Reactin(x)+Moment due to (M)

$$y*e=x(t_{R.c.}+t_{p.c.})+M \longrightarrow \boxed{e=\frac{x(t_{R.c.}+t_{p.c.})+M}{y}}$$

Steps of design

1-Get the loads on the secondary beams from load distribution and get their reactions on the frame.

2-Get the distributed load on the frame.

$$\boxed{w_u=\gamma_c\, b(t-t_s)*1.40+\frac{\Sigma Area}{span}\, w_s}$$

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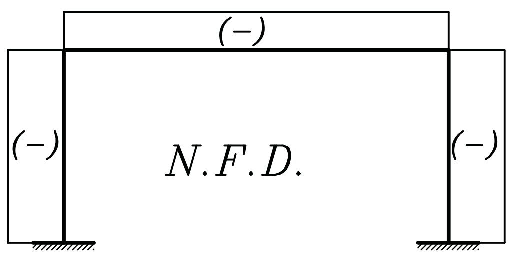
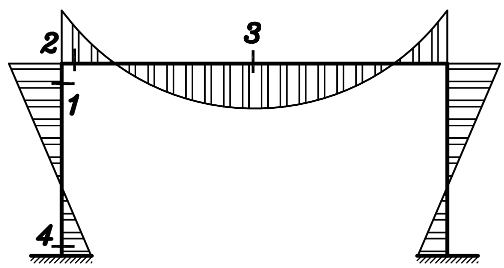
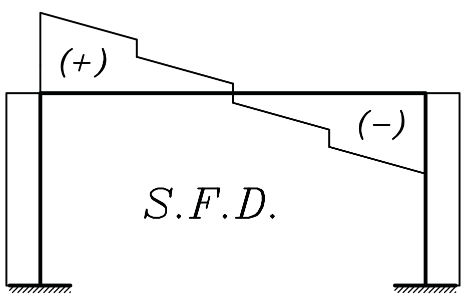
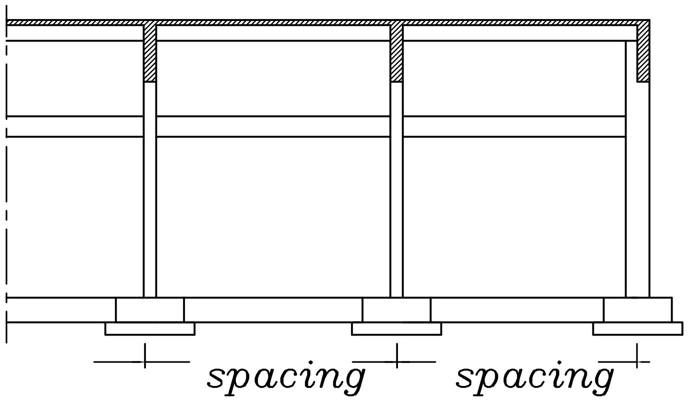
4- Draw B.M.D , N.F.D. , S.F.D.



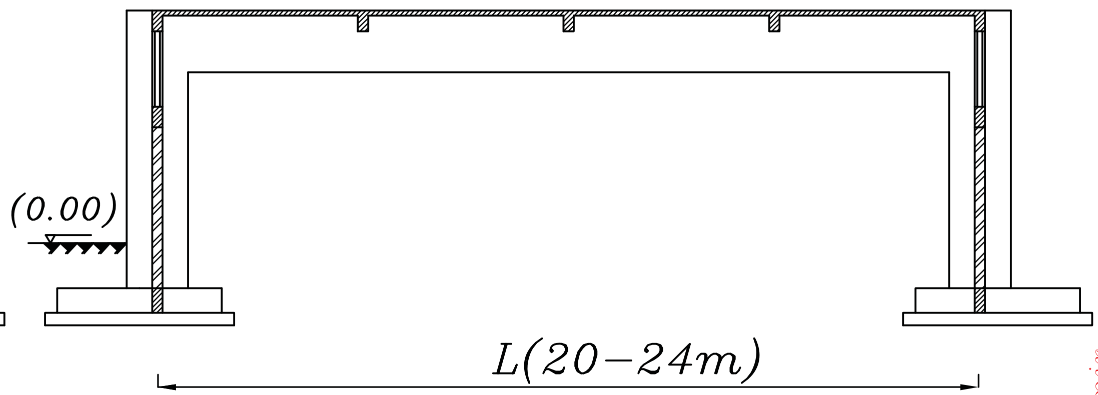




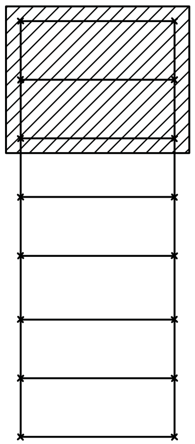
5-Design sections (1-1),(2-2),(3-3),(4-4) and get rft.



Side view

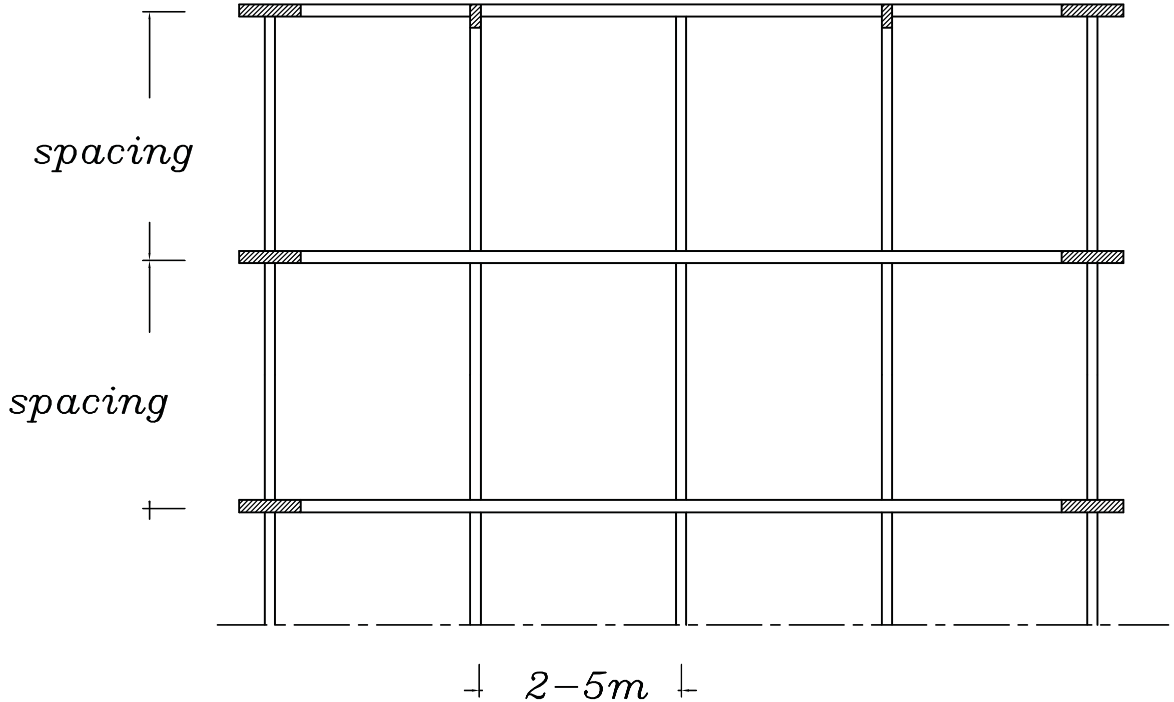


Elevation



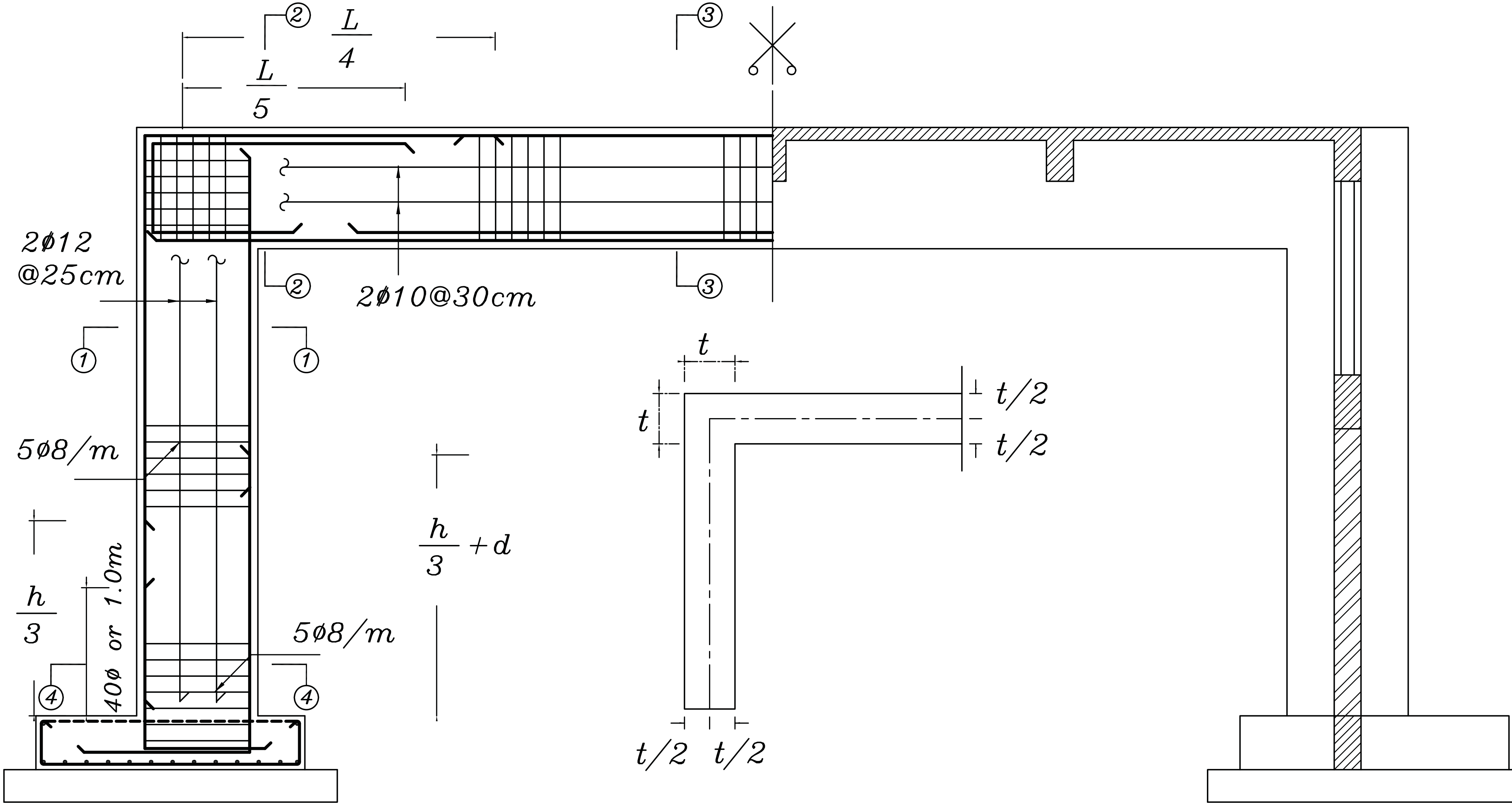
KEY PLAN

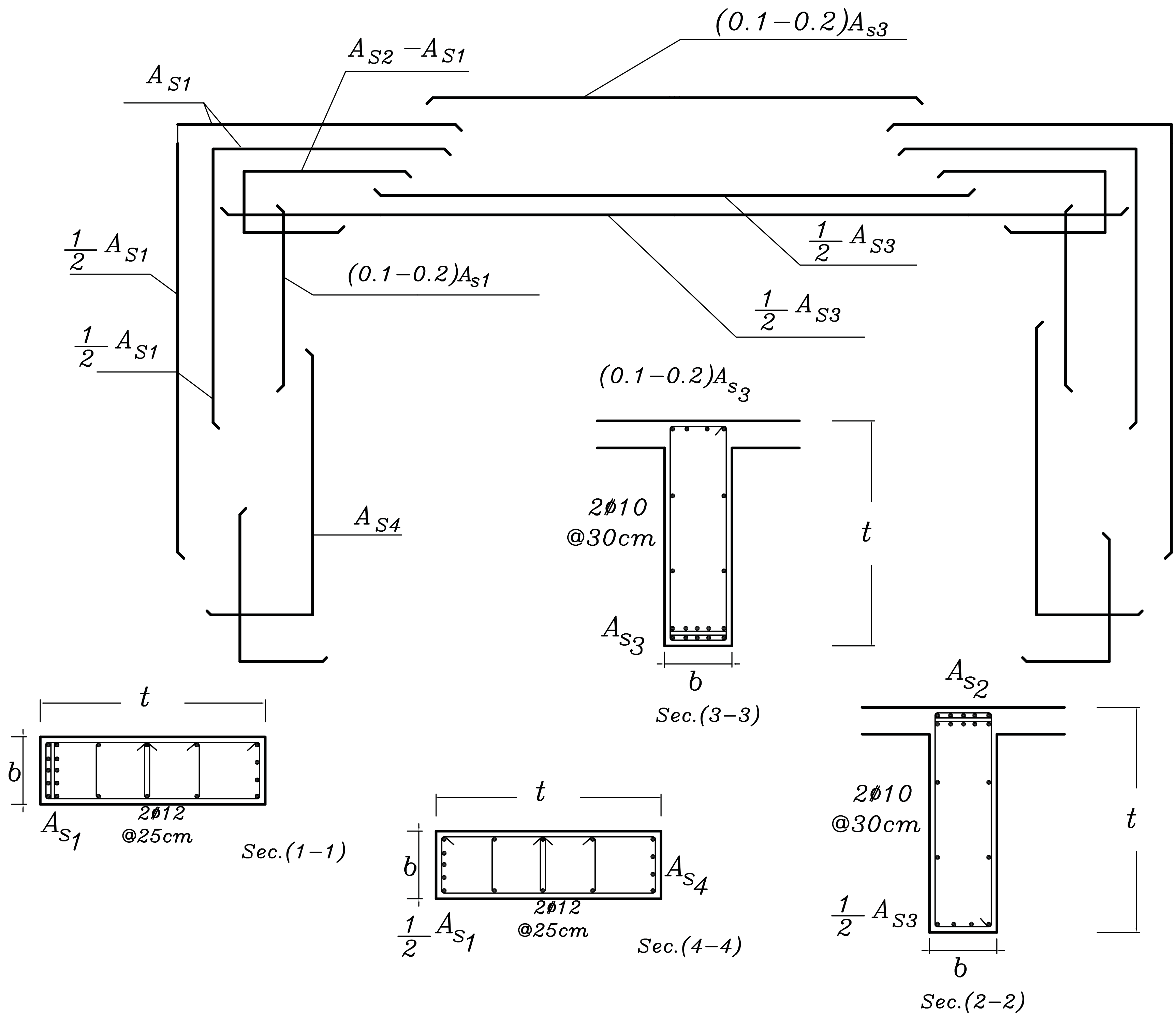
1:200 ⟶ 1:400



Plan

R.F.T. of the Frame




$(0.1-0.2)A_{s3}$
$A_{S2} - A_{S1}$
A_{S1}
$\frac{1}{2} A_{S1}$
$\frac{1}{2} A_{S1}$
$(0.1-0.2)A_{s1}$
$\frac{1}{2} A_{S3}$
$\frac{1}{2} A_{S3}$
A_{S4}
$(0.1-0.2)A_{s_3}$
$2\phi10$ @30cm
A_{s_3}
t
b
Sec.(3-3)
A_{s_2}
$2\phi10$ @30cm
t
$\frac{1}{2} A_{S3}$
b
Sec.(2-2)
t
b
A_{s_1}
$2\phi12$ @25cm
Sec.(1-1)
t
b
A_{s_4}
$\frac{1}{2} A_{s_1}$
$2\phi12$ @25cm
Sec.(4-4)

Solved examples on frames

Example

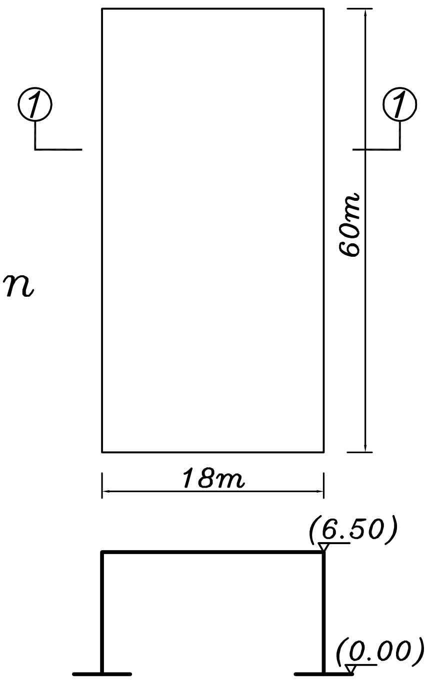
For the given plan and cross- section,

it is required to:

1- Draw structural plan and cross section

to show all concrete elements.

2- Design the slabs and Main supporting



Sec.(1-1)

given

$f_{cu}=27.5N/mm^2$ $\quad f_y=360N/mm^2$

$F.C.=1.5kN/m^2$ $\quad L.L.=1.0kN/m^2$

Solution

1-Design for solid slabs:

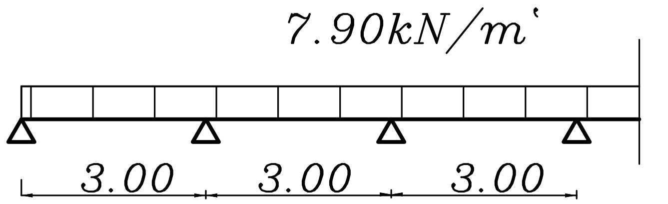
$$t_s=\frac{L_s}{24}=\frac{300}{24}=12.50cm$$

take $t_s=$ 12cm for all slabs (check deflection)

$$w_{su}=1.4(t_s\,\gamma_c+F.C.)+1.6L.L.$$

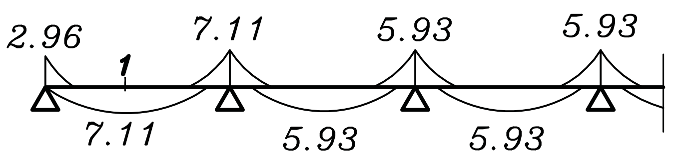
$$=1.4[0.12*25+1.5]+1.6*1.0$$

$$w_{su}=7.90\ kN/m^2$$



Design of strip

Sec. (1-1)



$$100=C_1\sqrt{\frac{7.11*10^6}{1000*27.5}}\quad C_1=6.22\ ,\ J=0.826$$

$$A_s=\frac{7.11*10^6}{0.826*100*360}=239\ mm^2$$

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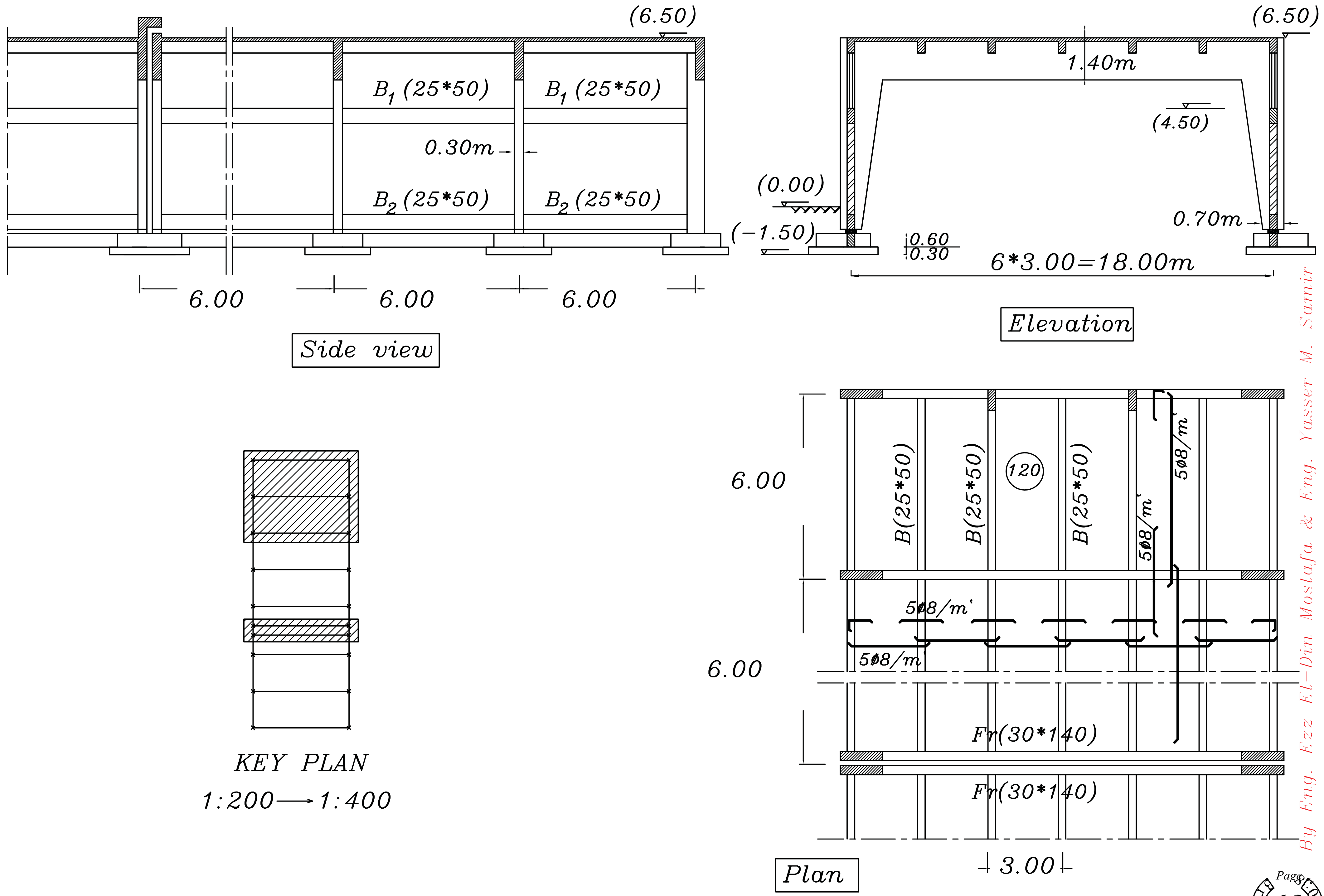

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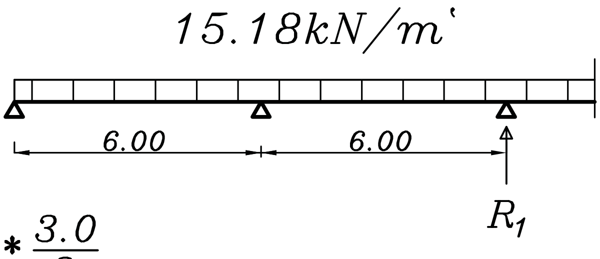
Take $As = 5\Phi 8/m'$ for all slabs

2- Design for secondary beams

For B_1



$$w_1 = \gamma_c b(t-t_s)*1.4+w_s \frac{L_s}{2}$$

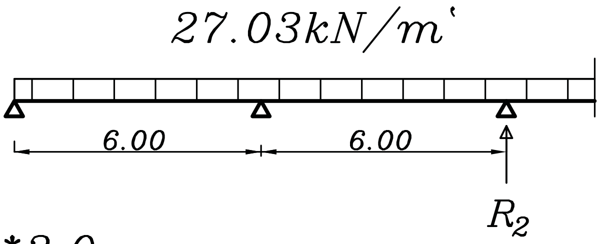
$$w_1 = 25*0.25(0.5-0.12)*1.40+7.9*\frac{3.0}{2}$$

$$w_1 = 15.18kN/m'$$

$$R_1 = w_1 * \text{ Spacing}$$

$$R_1 = 15.18*6 = 91.05kN$$

For B_2



$$w_2 = \gamma_c b(t-t_s)*1.4+w_s .L_s$$

$$w_2 = 25*0.25(0.5-0.12)*1.40+7.9*3.0$$

$$w_2 = 27.03kN/m'$$

$$R_2 = w_2 * \text{ Spacing}$$

$$R_2 = 27.03*6 = 162.15kN$$

3-Design of Main System

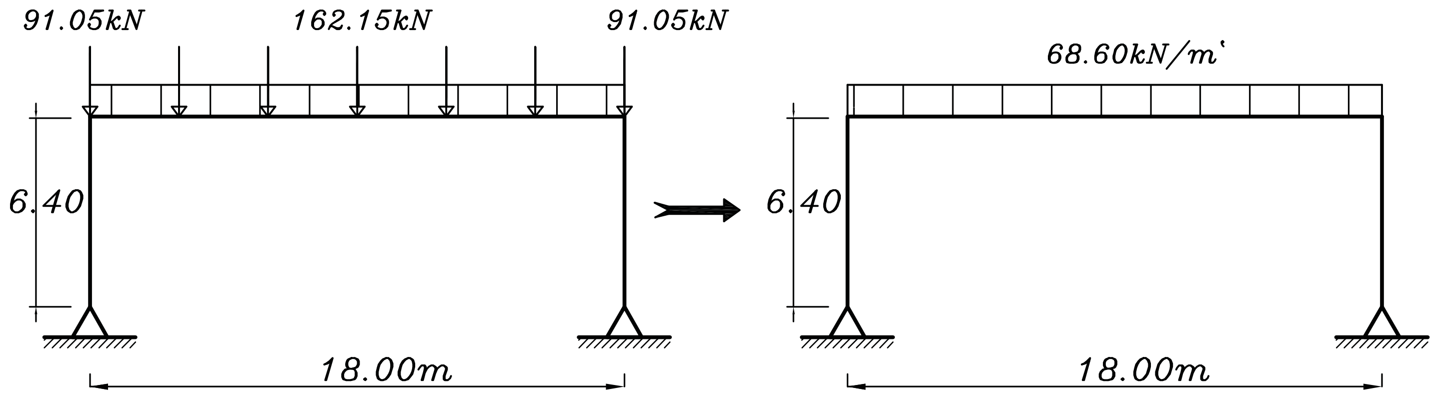
assume $b = 30cm$, $t = \frac{L}{12-14} = \frac{18}{12-14} = 1.40m$

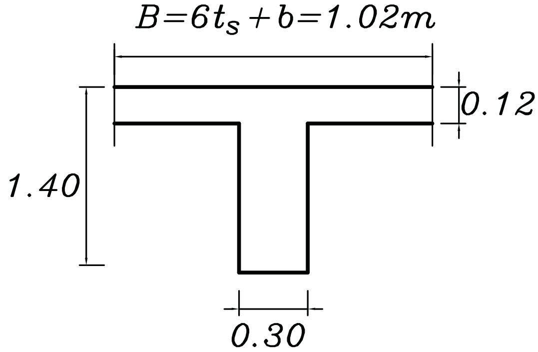
$$w_{eq} = o.w + \frac{\Sigma P}{L}$$

$$w_{eq} = 25*0.3*(1.4-0.12)*1.40+ \frac{162.15*5+91.05*2}{18}$$

$$w_{eq} = 68.60 \text{ kN/m'}$$

$$h = 6.50+1.50-0.30-0.60-\frac{1.40}{2} = 6.40m$$





$$I_b = 349*10^{-4}*1.02*1.4^3$$

$$I_b = 0.098 m^4$$

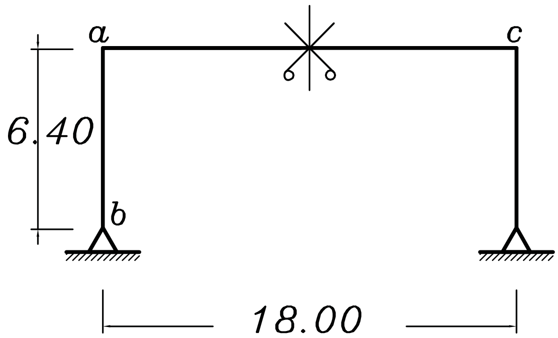
$$I_c = \frac{B(\frac{5}{6}t)^3}{12} = \frac{0.3*(\frac{5}{6}*1.40)^3}{12}$$

$$I_c = 0.0397 m^4$$

$$\frac{t_s}{t} = \frac{0.12}{1.40} = 0.086$$

$$\frac{b_0}{B} = \frac{0.3}{1.02} = 0.29$$

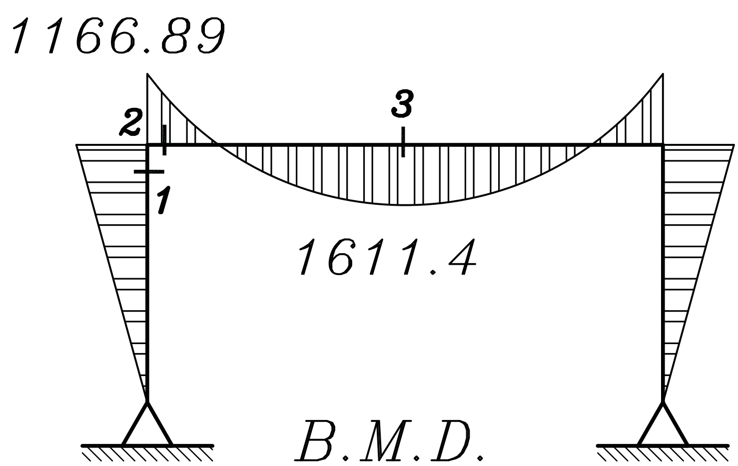
<u>*For Joint a*</u>



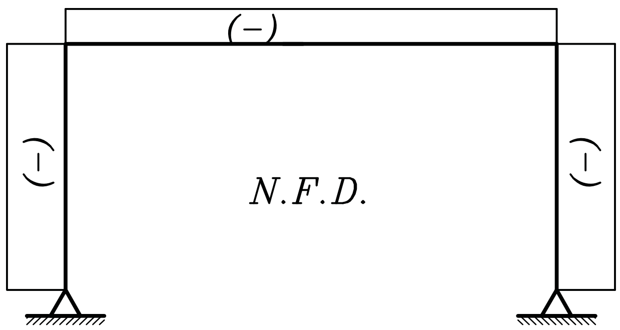
$$D.f_{ab} = \frac{0.75(I_c/h)}{(0.75\frac{I_c}{h})+(0.5\frac{I_b}{L})}$$

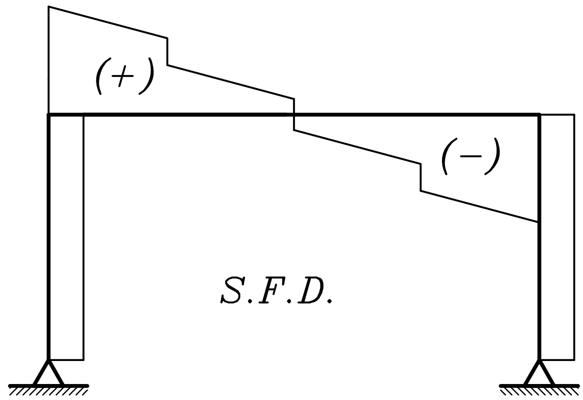
$$D.f_{ab} = \frac{0.75*(0.0397/6.40)}{0.75*(0.0397/6.40)+0.50*(0.098/18)}$$

$$D.f_{ab} = 0.63$$



B.M.D.

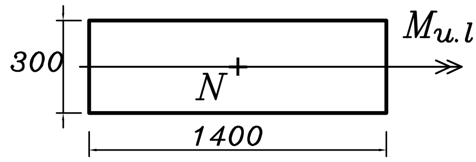




Design of Sections

Sec. (1−1) $M_{u.l.} = 1166.89 kN.m$ $N_{u.l.} = 617.64 kN.m$

$b = 300 mm$, $t = 1400 mm$



$$\frac{N_{u.l.}}{btf_{cu}} = \frac{617.64*10^3}{300*1400*27.5} = 0.05 > 0.04 \text{ (Dont neglect } N_{u.l.} \text{)}$$

$$e = \frac{M_{u.l.}}{N_{u.l.}} = \frac{1166.89}{617.64} = 1.89 m$$

$$\frac{e}{t} = \frac{1.89}{1.40} = 1.35 > 0.5 \text{ (big eccentricity)}$$

$$e_s = e + \frac{t}{2} - c = 1.89 + \frac{1.40}{2} - 0.1 = 2.49 m$$

$$M_{us} = 617.64*2.49 = 1537.9 kN.m$$

$$d = C_1 \sqrt{\frac{M_{us}}{b*f_{cu}}}$$

$$1300 = C_1 \sqrt{\frac{1537.9*10^6}{300*27.5}} \qquad C_1 = 3.01 \quad \& \quad J = 0.752$$

$$A_s = \frac{M_{us}}{J.d.f_y} - \frac{N_{us}}{f_y / \gamma_s}$$

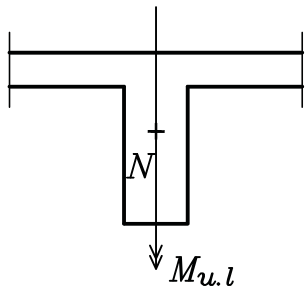
$$A_s = \frac{1537.9*10^6}{0.752*1300*360} - \frac{617.64*10^3}{360/1.15}$$

$$A_s = 24 cm^2 = 7\phi 22$$

Sec. (2−2) $\quad M_{u.l.} = 1166.89 kN.m \qquad N_{u.l.} = 209.81 kN.m$

$b = 300mm \quad , \qquad t = 1400mm$

$$\frac{N_{u.l.}}{btf_{cu}} = \frac{209.81*10^{3}}{300*1400*27.5} = 0.018 < 0.04 \quad (\ neglect\ \ N_{u.l.}\ )$$



$$d = C_1 \sqrt{\frac{Mu.l.}{b*f_{cu}}}$$

$$1300 = C_1 \sqrt{\frac{1166.89*10^{6}}{300*27.5}} \qquad C_1 = 3.46 \quad \& \quad J = 0.778$$

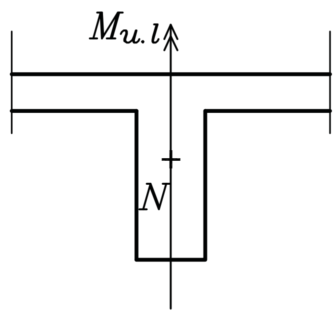
$$A_s = \frac{1166.89*10^{6}}{0.778*1300*360}$$

$$A_s = 32.05 cm^2 = 9\phi22$$

Sec. (3−3) $\quad M_{u.l.} = 1611.4 kN.m \qquad N_{u.l.} = 209.81 kN.m$

$b = 300mm \quad , \qquad t = 1400mm$

$$\frac{N_{u.l.}}{btf_{cu}} = \frac{209.81*10^{3}}{300*1400*27.5} = 0.018 < 0.04 \quad (\ neglect\ \ N_{u.l.}\ )$$



$$B = \begin{cases} 16ts + b = 16*120 + 300 = 2220mm \\ ℄ \longrightarrow ℄ = 6000mm \\ \frac{KL}{5} + b = \frac{0.76*18000}{5} + 300 = 3036mm \end{cases}$$

$B = 2220mm$

$$d = C_1 \sqrt{\frac{Mu.l.}{B*f_{cu}}}$$

$$1300 = C_1 \sqrt{\frac{1611.4*10^{6}}{2220*27.5}} \qquad C_1 = 8.0 \quad \& \quad J = 0.826$$

$$A_s = \frac{1611.4*10^{6}}{0.826*1300*360}$$

$$A_s = 41.68 cm^2 = 9\phi25$$

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Check Shear

$$Q_{cr} = Q_{max} - w\left(\frac{c}{2} + \frac{d}{2}\right)$$

$$Q_{cr} = 526.59 - 58.51\left(\frac{1.40}{2} + \frac{1.30}{2}\right)$$

$$Q_{cr} = 447.60kN$$

$$q_{su} = \frac{Q_{cr}}{bd} = \frac{447.60*10^3}{300*1300} = 1.15 \;\; N/mm^2$$

$$q_{cu} = 0.24\sqrt{\frac{27.5}{1.5}} = 1.03 \;\; N/mm^2$$

$$\mathbf{q}_{cu} < \mathbf{q}_u < \mathbf{q}_{umax}$$

$$q_{max} = 0.7\sqrt{\frac{27.5}{1.5}} = 3.00 \;\; N/mm^2$$

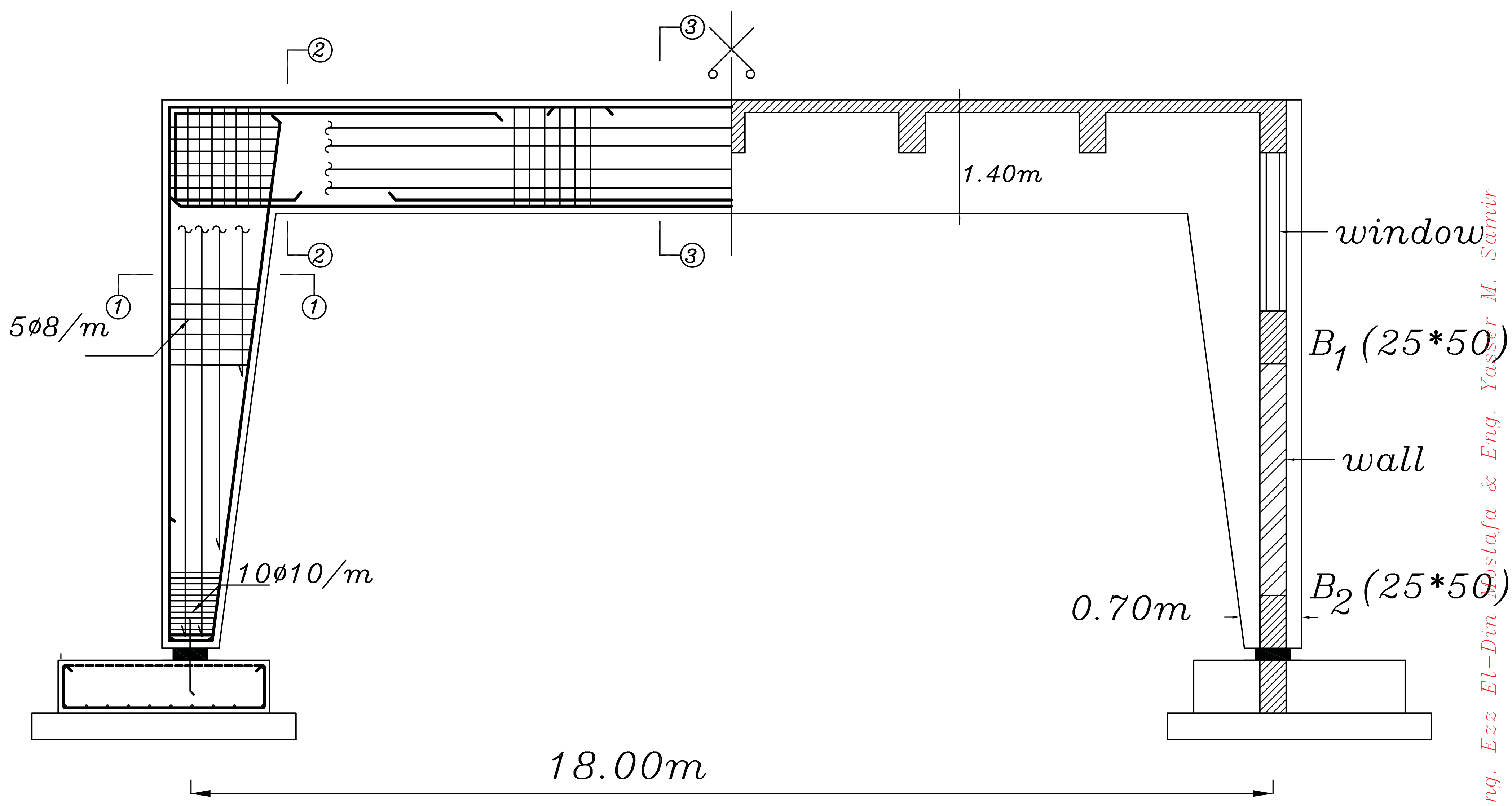
$$q_u - \frac{q_{cu}}{2} = \frac{nA_s\, f_y / \gamma_s}{bS}$$

assume $n=2$ $\qquad A_s = 78.5mm^2 = \phi 10$

$$1.15 - \frac{1.03}{2} = \frac{2*78.5*240/1.15}{300*S} \longrightarrow S = 172mm$$

$$No.of \;\; stirrups/m' = \frac{1000}{S} = 5.8$$ **Take Stirrups $6\phi 10/m'$**

R.F.T. of the Frame



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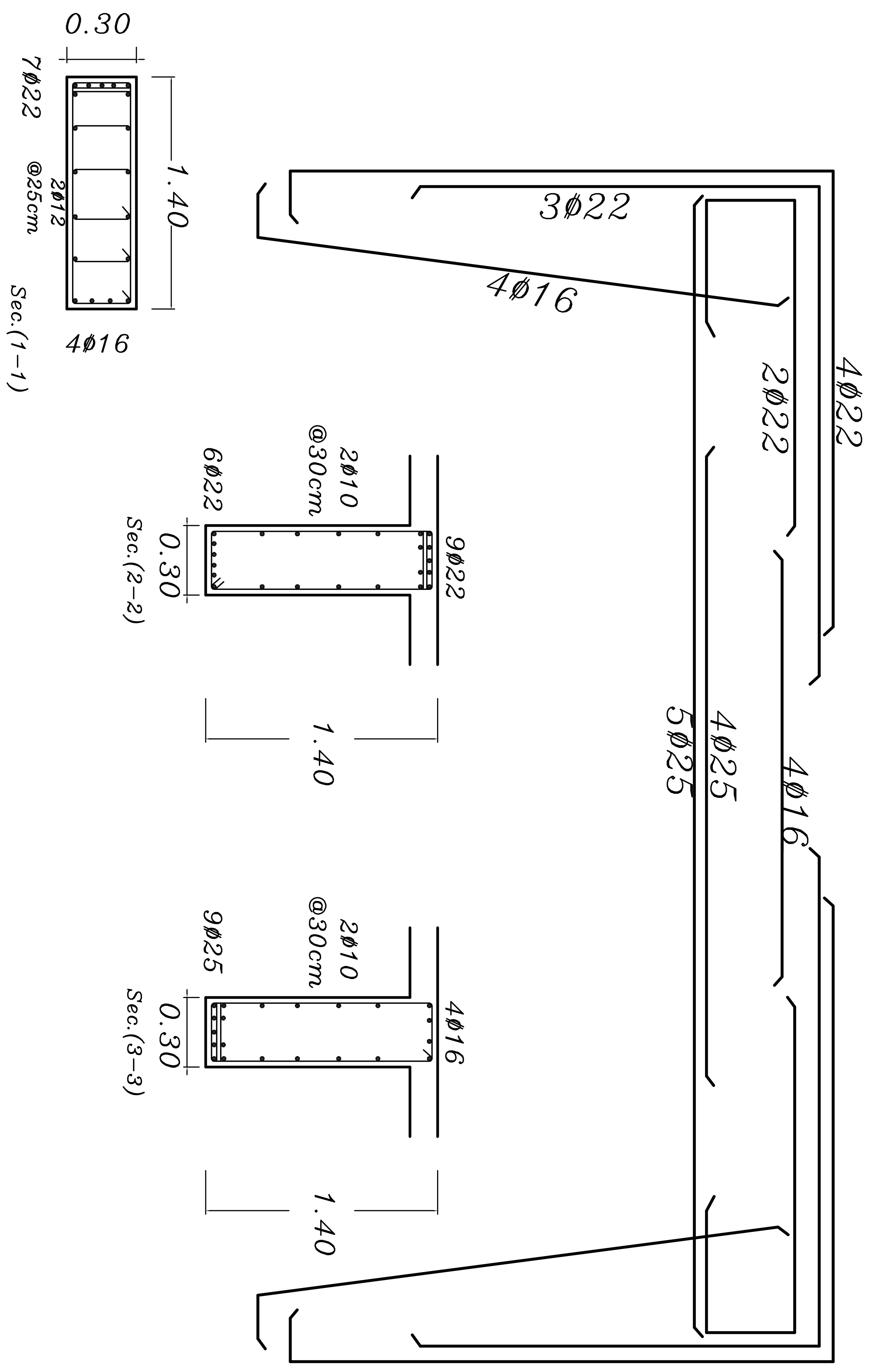


0.30
7Ø22
1.40
2Ø12
@25cm
4Ø16
Sec.(1–1)
3Ø22
4Ø16
4Ø22
2Ø22
6Ø22
2Ø10
@30cm
9Ø22
0.30
Sec.(2–2)
1.40
5Ø25
4Ø25
4Ø16
9Ø25
2Ø10
@30cm
4Ø16
0.30
Sec.(3–3)
1.40

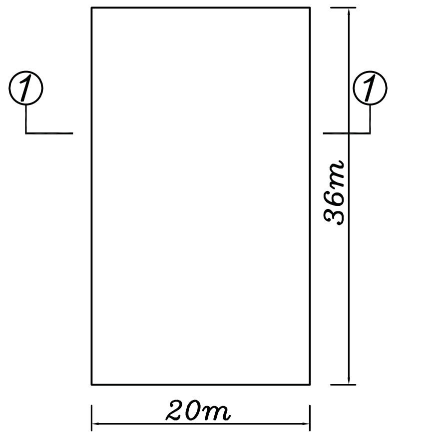
Example

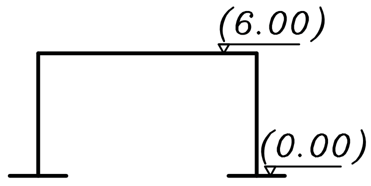
For the given plan and cross- section,
Columns are only allowed on the outside perimeter

it is required to:

1- Draw structural plan and Elevation to show all concrete elements.

2- Design the slabs and Main supporting element.





Sec.(1-1)

Use Blocks(200*200*400)

O.W.(blocks)=0.15 kN/block

given

$f_{cu}=30N/mm^2$ $f_y=360N/mm^2$ $F.C.= 1.5kN/m^2$

$L.L.=2.0kN/m^2$

Solution

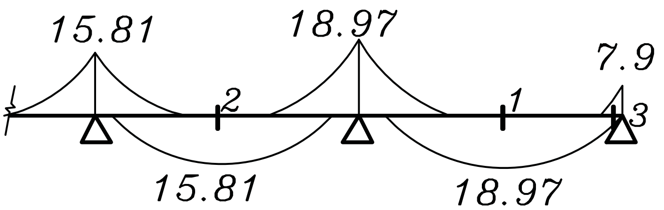
For one way H.B. Slabs.

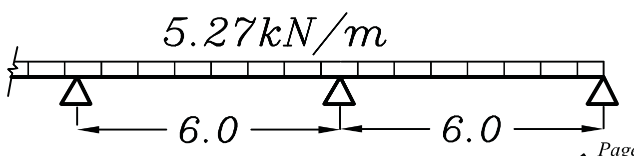
assume $t=250mm$ & $t_s=50mm$ & $h=200mm$

$$w_{u.l}=1.4(t_s\gamma_c+f.c.+2bh\gamma_c+10*wt.of\ Block)+1.6\ L.L$$

$$w_{u.l}=1.4(0.05*25+1.5+2*0.1*0.2*25+10*0.15)+1.6*2.0$$

$w_{u.l}= 10.55\ kN/m$ $\qquad w_{rib}= 5.27kN/m$





Design of Sections.

Sec. (1-1) $M_{u.l.} = 18.97 kN.m$

$d = 250 - 30 = 220 mm$

$$d = C_1 \sqrt{\frac{M_{u.l.}}{f_{cu} * b}} \qquad 220 = C_1 \sqrt{\frac{18.97*10^6}{30*500}} \qquad C_1 = 6.2 \quad J = 0.826$$

$$A_s = \frac{M_{u.l.}}{J\ f_y\ d} = \frac{18.97*10^6}{360*0.826*220} = 290 mm^2/rib$$

$\boxed{1\phi12 + 1\phi16/rib}$

Sec. (2-2) $M_{u.l.} = 15.81 kN.m$

$$d = C_1 \sqrt{\frac{M_{u.l.}}{f_{cu} * b}} \qquad 220 = C_1 \sqrt{\frac{15.81*10^6}{30*500}} \qquad C_1 = 6.8 \quad J = 0.826$$

$$A_s = \frac{M_{u.l.}}{J\ f_y\ d} = \frac{15.81*10^6}{360*0.826*220} = 242 mm^2/rib$$

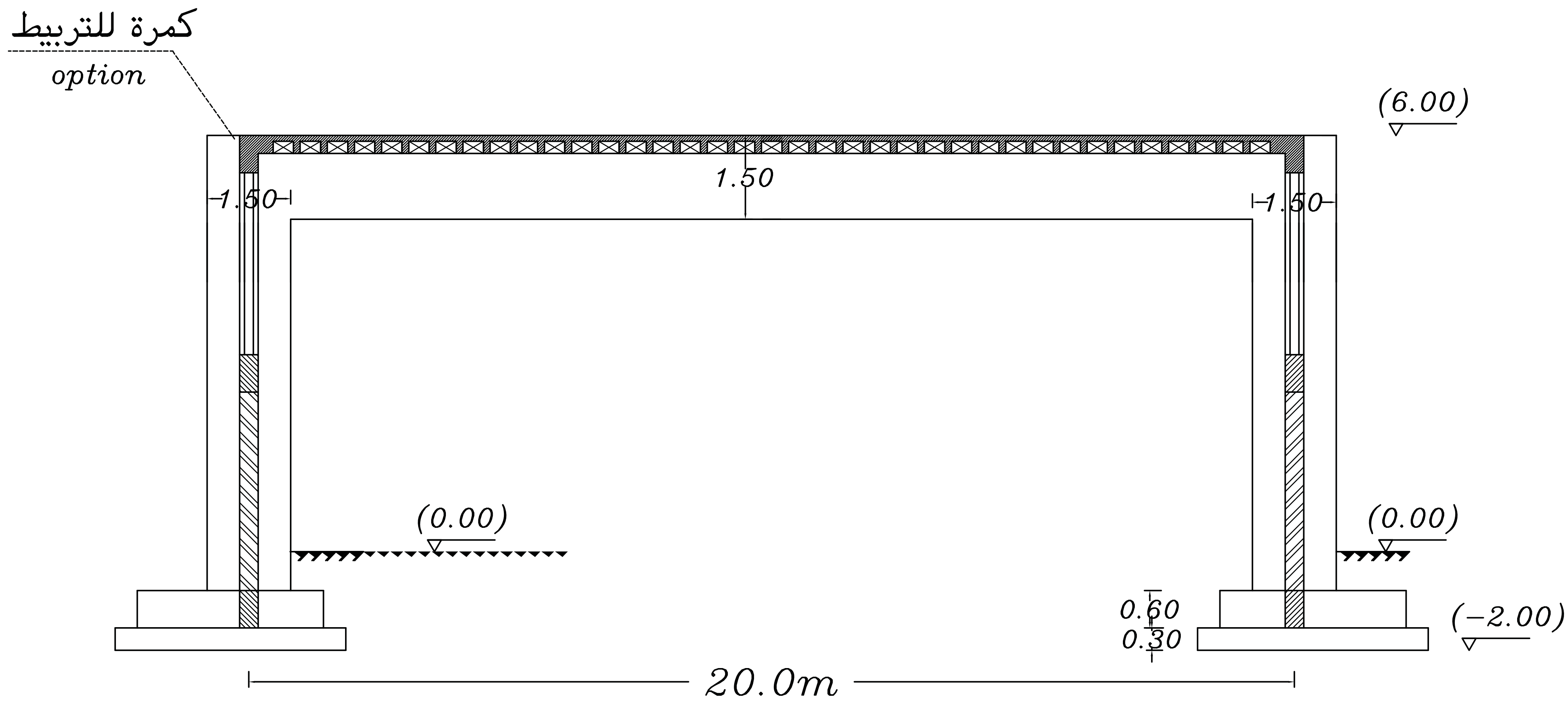
$\boxed{1\phi12 + 1\phi16/rib}$

Sec. (3-3) $M_{u.l.} = 7.9 kN.m$

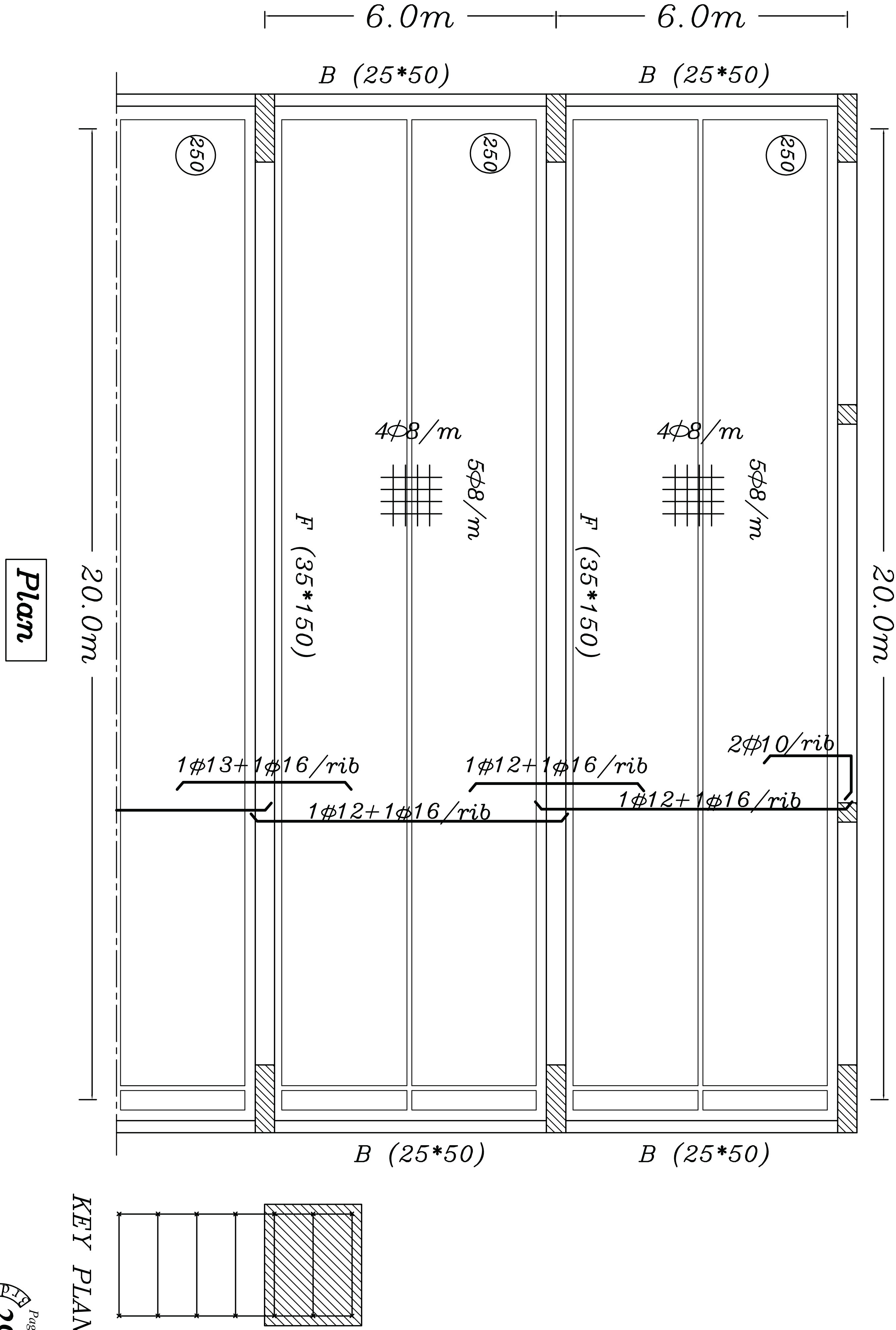
$$d = C_1 \sqrt{\frac{M_{u.l.}}{f_{cu} * b}} \qquad 220 = C_1 \sqrt{\frac{7.9*10^6}{30*500}} \qquad C_1 = 9.5 \quad J = 0.826$$

$$A_s = \frac{M_{u.l.}}{J\ f_y\ d} = \frac{7.9*10^6}{360*0.826*220} = 121 mm^2/rib$$

$\boxed{2\phi10/rib}$



Elevation


6.0m
6.0m
B (25*50)
B (25*50)
250
250
250
Plan
20.0m
20.0m
4Φ8/m
4Φ8/m
5Φ8/m
5Φ8/m
F (35*150)
F (35*150)
2Φ10/rib
1φ13+1φ16/rib
1φ12+1φ16/rib
1φ12+1φ16/rib
1φ12+1φ16/rib
B (25*50)
B (25*50)
KEY PLAN

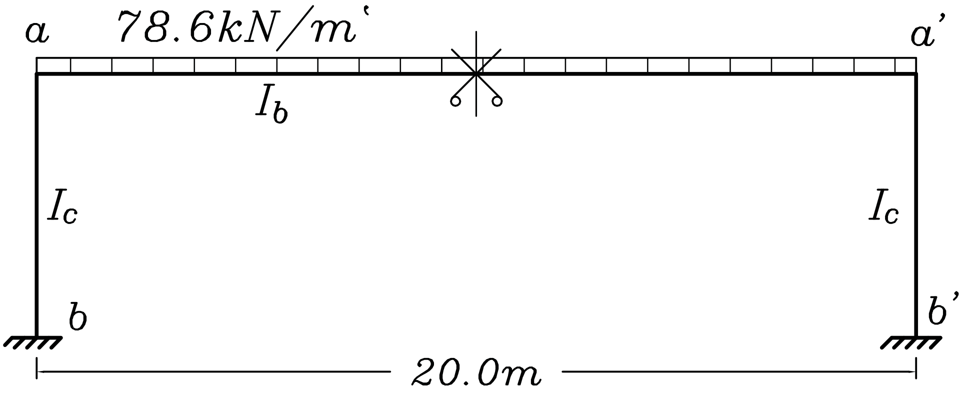
Design of Main System

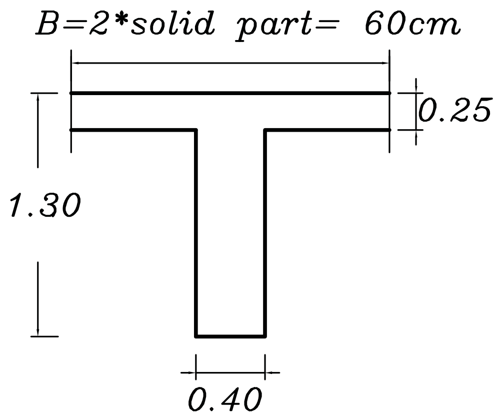
Assume $b=35cm$, $t=\frac{L}{14-16}=1.5m$

$w=o.w+w_s*S$

$o.w.=25*0.35(1.5-0.25)*1.40=15.3kN/m'$

$w=10.55*6+15.3 = 78.6 \ kN/m$





Relative Stiffness,D.F.

$\underline{I_b}$

$\frac{t_s}{t}=\frac{0.25}{1.5}=0.17$

$\frac{b}{B}=\frac{0.35}{0.6}=0.58$

Old tables page 91 $\mu=600$

$I_b=600*10^{-4}*0.6*1.5^3=0.121 \ m^4$

$\underline{I_c}$ $I_c=\frac{bt^3}{12}=\frac{0.35*1.5^3}{12}=0.098 \ m^4$

$K_{ab}=\frac{I_c}{h}=\frac{0.098}{6.35}=0.015$

لاحظ ان هذا الارتفاع يقاس من
وجه القواعد الى C.L. ال girder

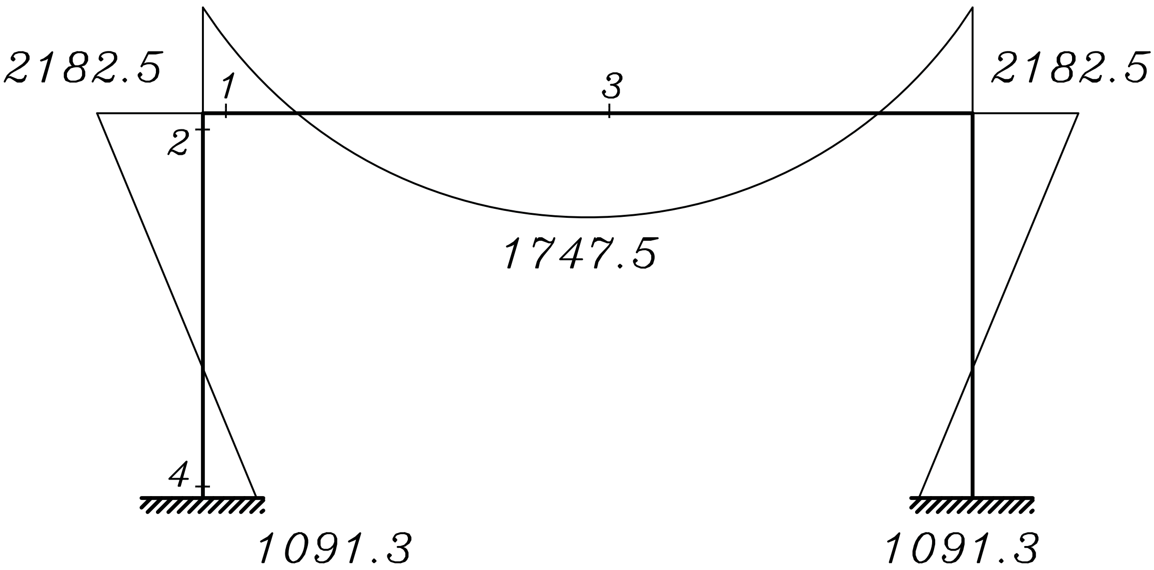
$K_{aa'}=\frac{1}{2}\frac{I_b}{L}=\frac{1}{2}*\frac{0.121}{20.0}=0.003$

$D.F_{ab}=\frac{K_{ab}}{K_{ab}+K_{aa'}}=\frac{0.015}{0.015+0.003}=0.833$

Fixed End Moment

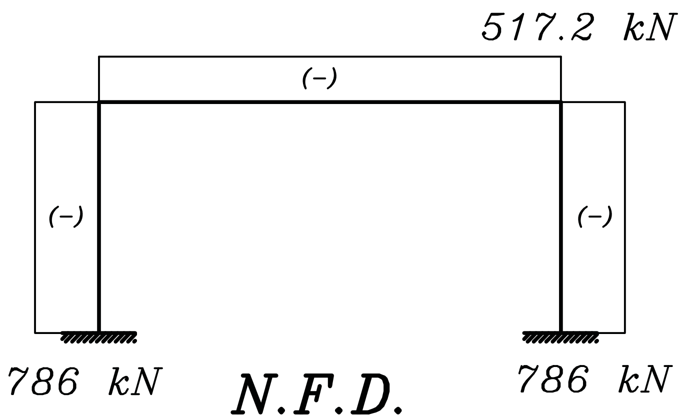
$$M = \frac{wL^2}{12} = \frac{78.6 * 20^2}{12} = 2620 \ kN.m$$

B.M.D.

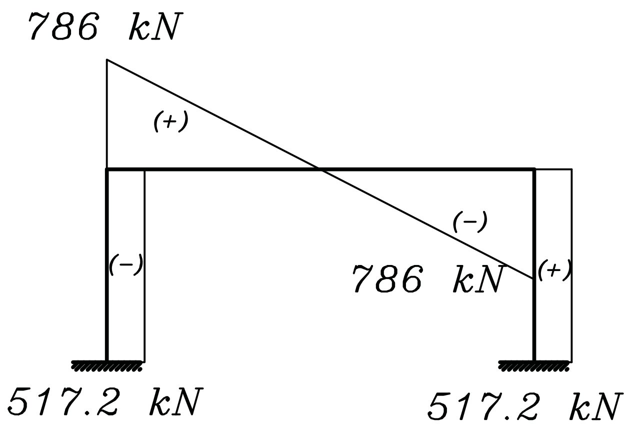


$$\therefore X = 517.2 \ kN$$

$$\therefore Y = \frac{\Sigma Loads}{2} = \frac{78.6*20}{2} = 786 \ kN$$



N.F.D.



S.F.D.

Sec(1−1): **R−Sec** $M_{u.l.}$ **=2182.5kN.m , d=1400 , b=350mm**

$N_{u.l.}$ **=517.2 kN**

$$\frac{N_{u.l.}}{f_{cu}* \; bt} = \frac{517.2*10^{3}}{30*350*1400} = 0.035>0.04 \quad (\text{ neglect N.F. })$$

$$d=C_1\sqrt{\frac{M_{u.l.}}{b*f_{cu}}}$$

$$1400=C_1\sqrt{\frac{2182.5*10^{6}}{350*30}} \qquad C_1=3.07 \quad J=0.75$$

$$A_s=\frac{2182.5*10^{6}}{0.75*1400*360}$$

$$A_s=5773mm^2$$

12ϕ25

Sec(2−2): **R−Sec** $M_{u.l.}$ **=2182.5kN.m , d=1400 , b=350mm**

$N_{u.l.}$ **=786 kN**

$$\frac{N_{u.l.}}{f_{cu}* \; bt} = \frac{786*10^{3}}{30*350*1400} = 0.053>0.04 \quad (\text{ use N.F. })$$

$$e=\frac{M_{u.l.}}{N_{u.l.}} = \frac{2182.5}{786} = 2.78m \qquad \frac{e}{t}=\frac{2.78}{1.5}=1.85>0.5$$

$\Rrightarrow$ ***Big ecc.***

$$e_s=e+\frac{t}{2}-c \qquad = 2.78+\frac{1.5}{2}-0.1 = 3.43 \; m$$

$$M_{us}=N_{u.l.}*e_s \qquad =786*3.43=2696kN.m$$

$$d=C_1\sqrt{\frac{M_{us}}{f_{cu}\; b}} \qquad 1400=C_1\sqrt{\frac{2696*10^{6}}{30*350}} \qquad C_1=2.78$$

$$J=0.71$$

$$A_s = \frac{M_{us}}{f_y\ J\ \ d} - \frac{N_{u.l.}}{f_y/\gamma_s}$$

$$A_s = \frac{2696*10^6}{360*0.71*1400} - \frac{786*10^3}{360/1.15} = 5023\ \ mm^2$$

$11\phi25$

<u>check A_{smin}</u>

$$A_{smin} = \frac{1.1}{f_y}\ bd = 1711\ \ mm^2$$

<u>Sec(3–3):</u> T–Sec $\boldsymbol{M_{u.l.} = 1747.5 kN.m\ ,\ \ d=1400}$

$N_{u.l.} = 517.2\ \ kN$ $B=600mm$

Neglect $N_{u.l.}$

$$1400 = C_1 \sqrt{\frac{1747.5*10^6}{600*30}} \Longrightarrow C_1 = 4.49 \quad J=0.82$$

$$A_s = \frac{1747.5*10^6}{0.82*1400*360} = 4228mm^2$$

$9\phi25$

<u>Sec(4–4):</u> R–Sec $\boldsymbol{M_{u.l.} = 1091.3kN.m\ ,\ \ d=1400\ ,\ \ b=350mm}$

$N_{u.l.} = 786\ \ kN$

$$\frac{N_{u.l.}}{F_{cu} *\ \ bt} = \frac{786*10^3}{30*350*1400} = 0.053 > 0.04 \qquad (\ use\ \ N.F.\ )$$

$$e = \frac{M_{u.l.}}{N_{u.l.}} = \frac{1091.3}{786} = 1.39m \qquad \frac{e}{t} = \frac{1.39}{1.5} = 0.93$$

$\Longrightarrow$ **Big ecc.**

$$e_s = e + \frac{t}{2} - c = 1.39 + \frac{1.5}{2} - 0.1 = 2.04\ \ m$$

$$M_{us} = N_{u.l.} * e_s = 786*2.04 = 1603kN.m$$

$$d = C_1 \sqrt{\frac{M_{us}}{f_{cu}\ \ b}} \qquad 1400 = C_1 \sqrt{\frac{1603*10^6}{30*350}} \qquad C_1 = 3.58 \quad J=0.78$$

$$A_s = \frac{M_{us}}{f_y\ J\ \ d} - \frac{N_{u.l.}}{f_y/\gamma_s}$$

$$A_s = \frac{1603*10^6}{360*0.78*1400} - \frac{786*10^3}{360/1.15} = 1566\ \ mm^2$$

5ø22

<u>check A_{smin}</u>

$$A_{smin} = \frac{1.1}{f_y}\, bd = 1497\ \ mm^2\ \ \text{O.K.}$$

<u>Check Shear</u>

$$Q_{cr} = Q_{max} - w\left(\frac{c}{2} + \frac{d}{2}\right)$$

$$Q_{cr} = 786 - 78.6\left(\frac{1.40}{2} + \frac{1.30}{2}\right)$$

$$Q_{cr} = 679.9kN$$

$$q_{su} = \frac{Q_{cr}}{bd} = \frac{679.9*10^3}{350*1400} = 1.39\ \ N/mm^2$$

$$q_{cu} = 0.24\sqrt{\frac{30}{1.5}} = 1.07\ \ N/mm^2$$

$$\boldsymbol{q_{cu} < q_u < q_{umax}}$$

$$q_{max} = 0.7\sqrt{\frac{30}{1.5}} = 3.13\ \ N/mm^2$$

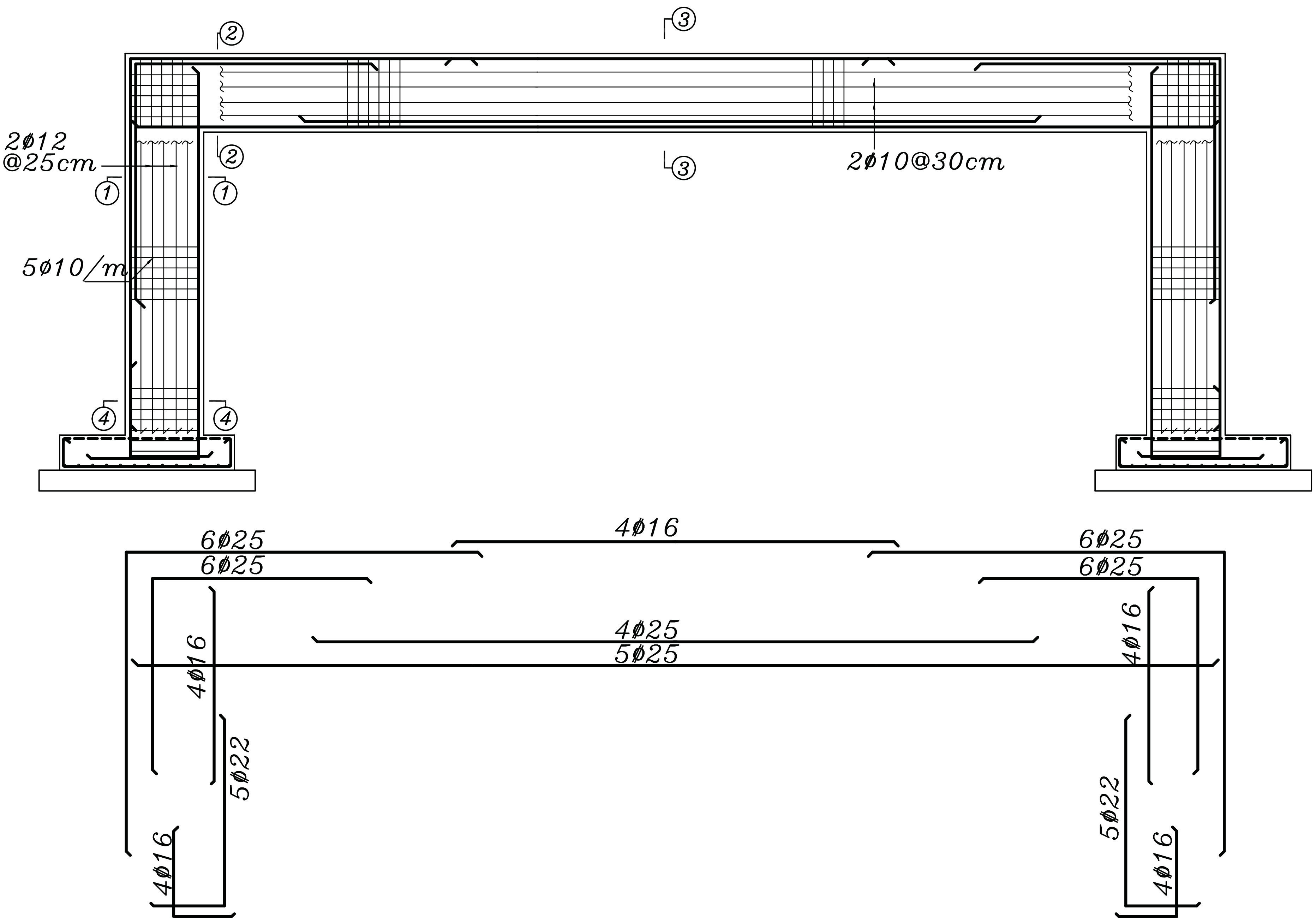
$$q_u - \frac{q_{cu}}{2} = \frac{nA_s\, f_y\ /\gamma_s}{bS}$$

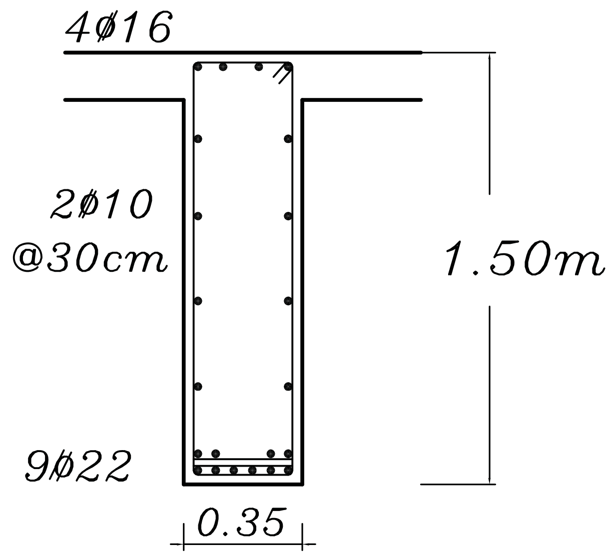
assume $n=2$ $\qquad\qquad A_s = 78.5mm^2 = ø10$

$$1.39 - \frac{1.07}{2} = \frac{2*78.5*240/1.15}{350*S} \longrightarrow S = 109mm$$

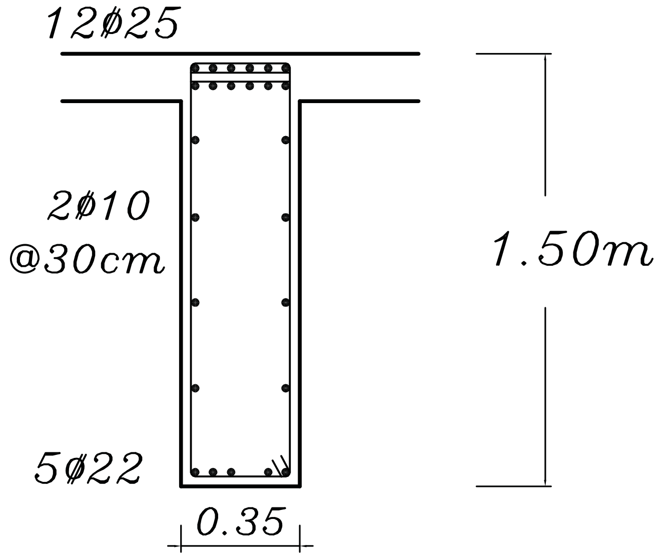
No.of stirrups/m' $= \frac{1000}{S} = 9.1$ **Take Stirrups 10ø10/m'**

R.F.T. of the Frame

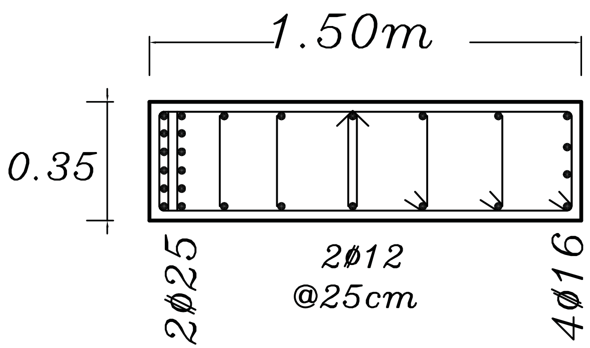




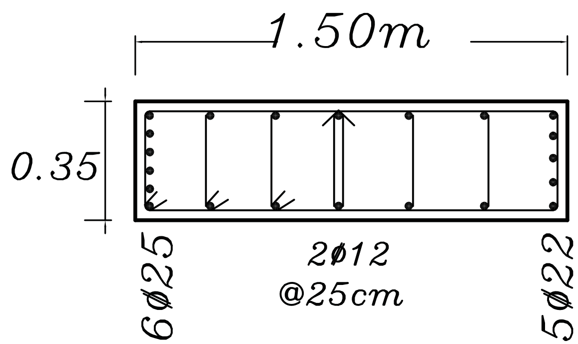
Sec.(3–3)



Sec.(2–2)



Sec.(1–1)



Sec.(4–4)

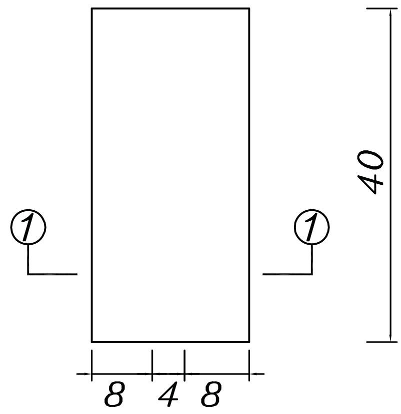
Example

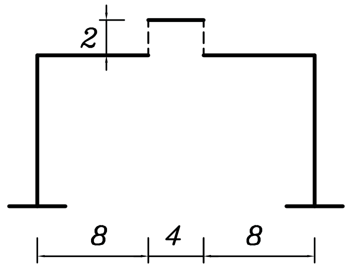
For the given plan and cross- section,

it is required to:

1- Draw structural plan and cross section to show all concrete elements.

2- Design the main supporting elements.





Sec.(1-1)

clear height=5.5m

given Use all Sec. Beams 25*50

$f_{cu}=25N/mm^2$ $f_y=360N/mm^2$

$F.C.=1.5kN/m^2$ $L.L.=1.0kN/m^2$

Solution

$t_s=\frac{400}{40}=10cm$ For sky light $t_s=\frac{400}{35}=11.43cm$

Take $t_s=10cm$ For all slabs except sky light,

take $t_s=12cm$

For $t_s=12cm$ $w_{su}=1.4[t_s\gamma_c+F.c.]+1.6\ L.L.$

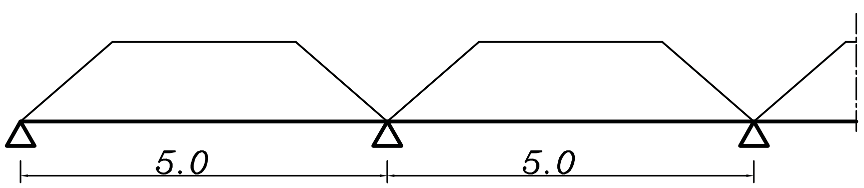
$w_{su}=1.4[0.12*25+1.5]+1.6*1=7.91kN/m^2$

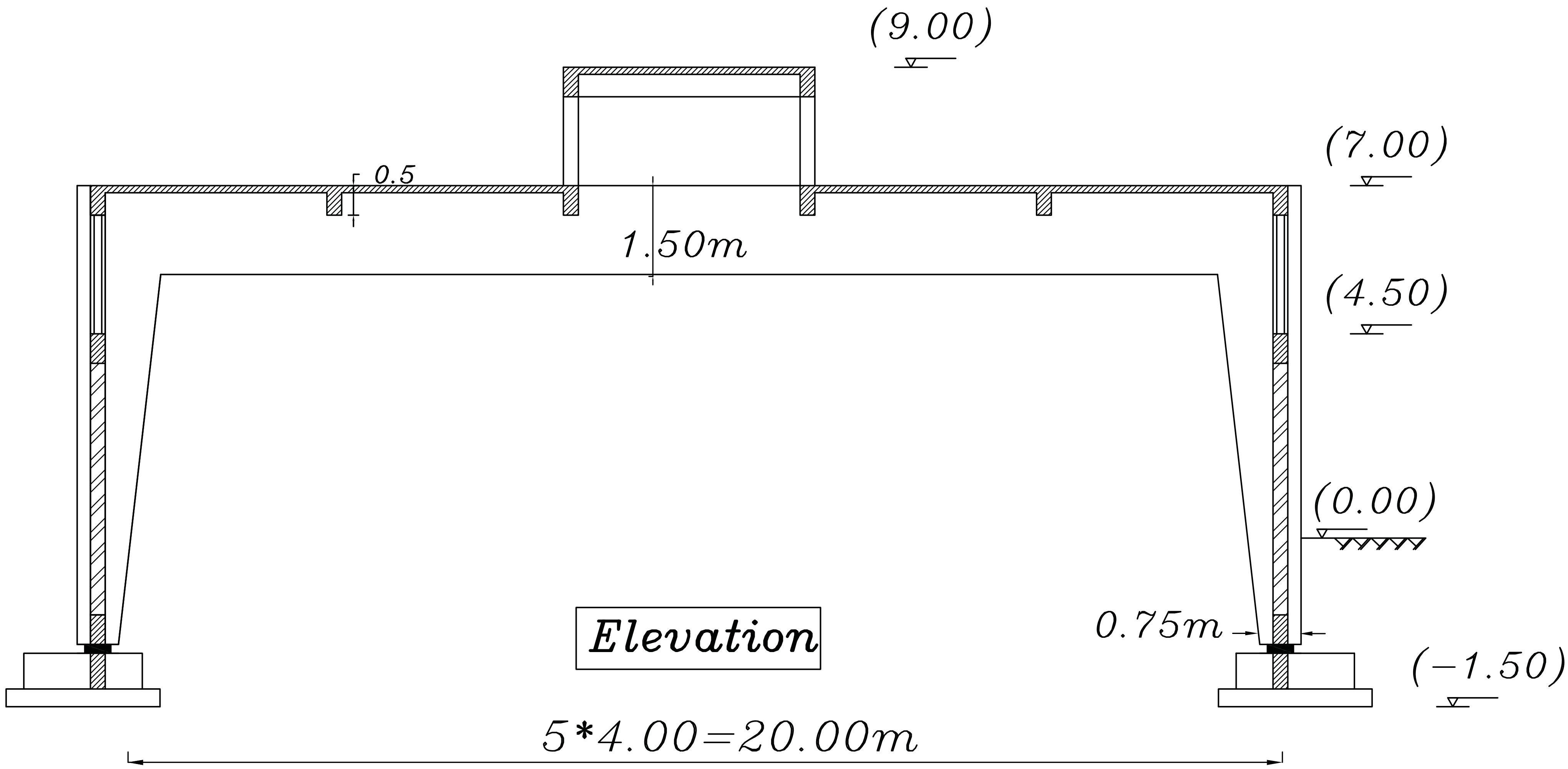
For $t_s=10cm$ $w_{su}=1.4[0.10*25+1.5]+1.6*1=7.2kN/m^2$

1-Analysis of Beams

For B_1

$$\boxed{C_a=1-\frac{1}{2}*\frac{4}{5}=0.60}$$

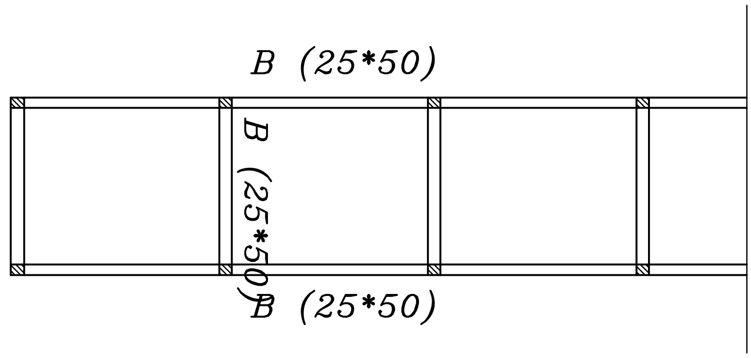




Elevation

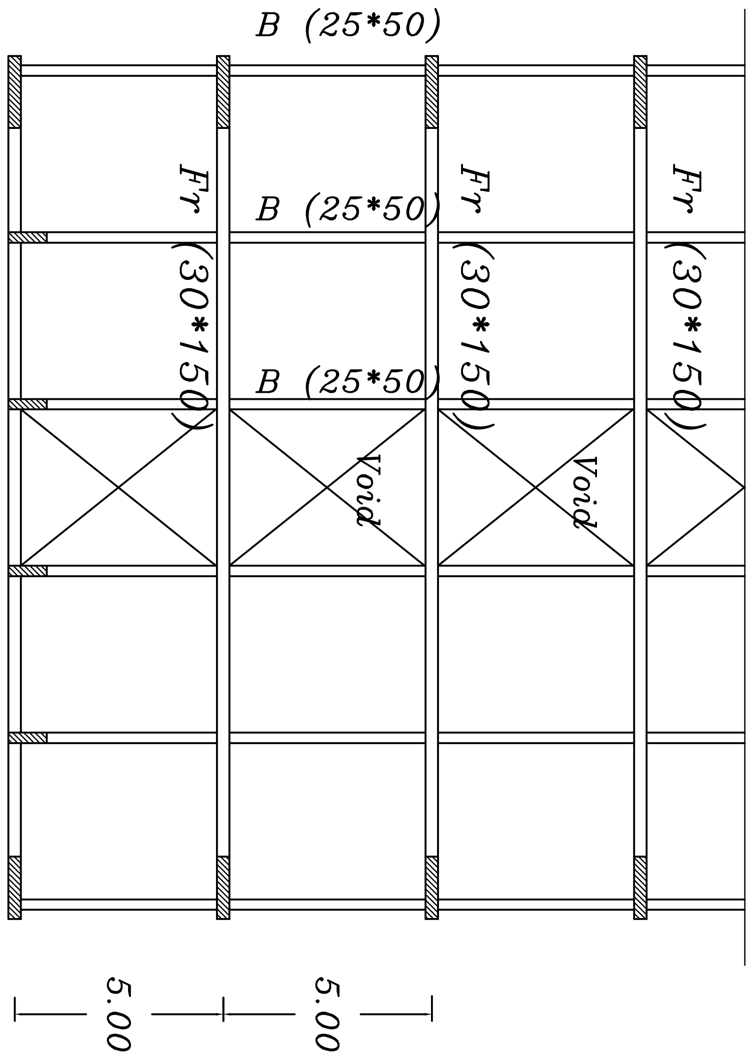
Plan

level (9.00)



Plan

level (7.00)

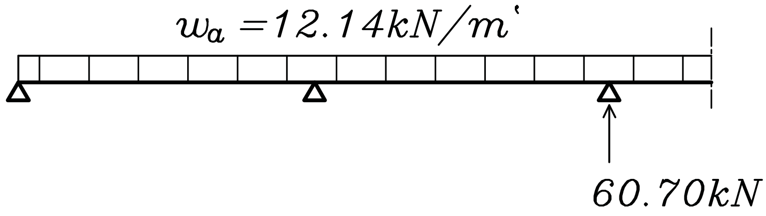


$$w_a = \gamma_c b(t - t_s) * 1.40 + C_a \frac{L_s}{2} w_s$$

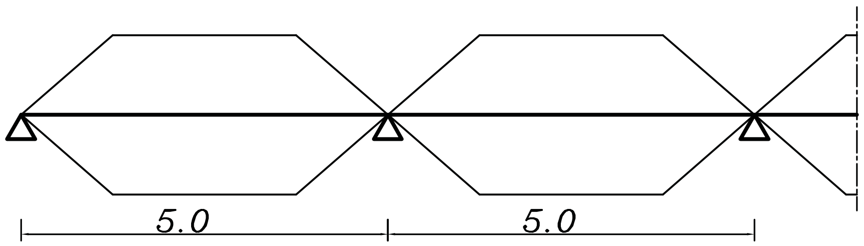
$$= 25 * 0.25[0.5 - 0.10] * 1.40 + 0.6 * \frac{4}{2} * 7.20$$

$$w_a = 12.14 kN/m'$$

$$R_1 = 12.14 * 5 = 60.7 kN$$



For B_2

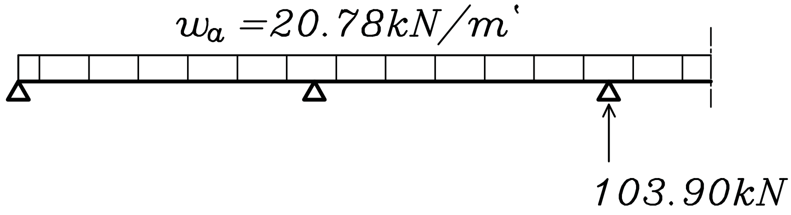


$$w_a = \gamma_c b(t - t_s) * 1.40 + C_a \frac{L_s}{2} w_s * 2$$

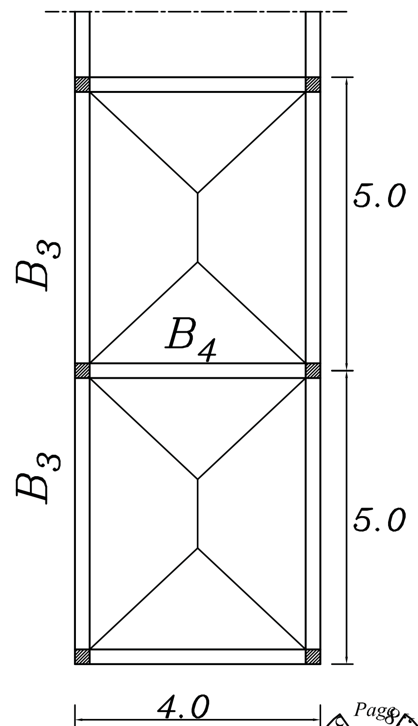
$$= 25 * 0.25[0.5 - 0.10] * 1.40 + 0.6 * \frac{4}{2} * 7.20 * 2$$

$$w_a = 20.78 kN/m'$$

$$R_2 = 20.78 * 5 = 103.9 kN$$



For sky light



For B_3

$$w_a = 25 * 0.25[0.5 - 0.12] * 1.40 + 0.6 * \frac{4}{2} * 7.90$$

$$w_a = 12.81 kN/m'$$

$$R_3 = 12.81 * 5 = 64.03 kN$$

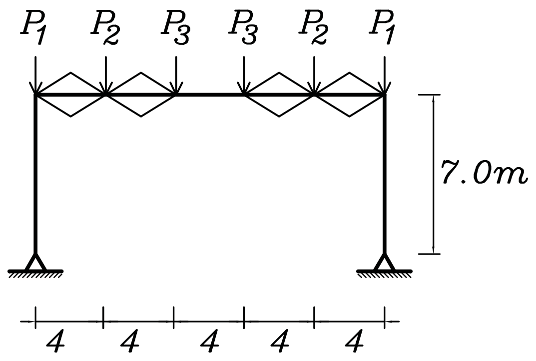
For B_4

$$w_a = 25 * 0.25[0.5 - 0.12] * 1.40 + 0.6 * \frac{4}{2} * 7.9 * 2$$

$$w_a = 19.13 kN/m'$$

$$R_4 = 19.13 * 2 = 38.25 kN$$

For Frame(1)



$b = 30cm$

$t = \frac{20}{12-14} = 1.5m$

$P_1 = 60.70kN$, $P_2 = 103.9kN$

$P_3 = R_1 + R_3 + R_4 + o.w$ of Post

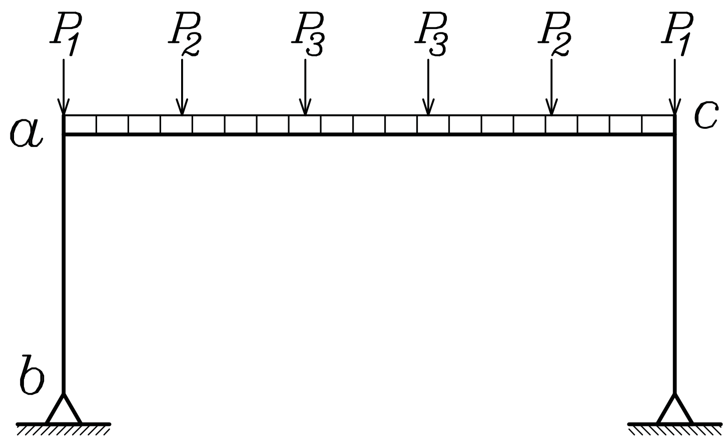
$= 60.7 + 64.03 + 38.25 + 0.25*0.25*25*1.4*2$

$P_3 = 167.36kN$

$w_a = w_e = \gamma_c b(t - t_s)*1.40 + \frac{\Sigma A}{Span} w_s$

$= 25*0.3[1.5-0.1]*1.40 + \frac{4*2*0.5*8}{2.0} *7.2$

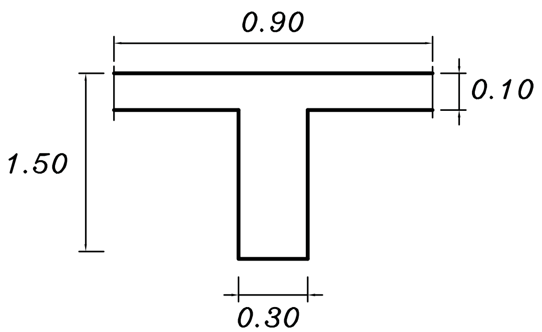
$w_a = w_e = 26.22 \ kN/m'$

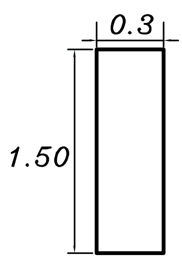


$I_c = \frac{0.3*(\frac{5}{6}*1.5)^3}{12} = 0.049m^4$

To get I_b:

we have two cross-sections





at midspan

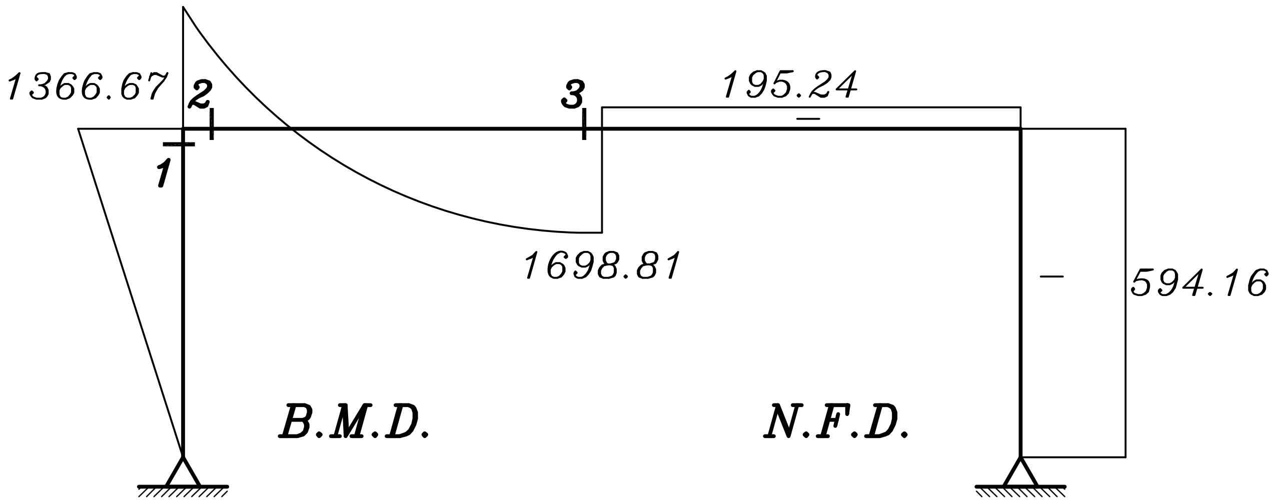
$I_{b2} = 363*10^{-4}*0.9*1.5^3$

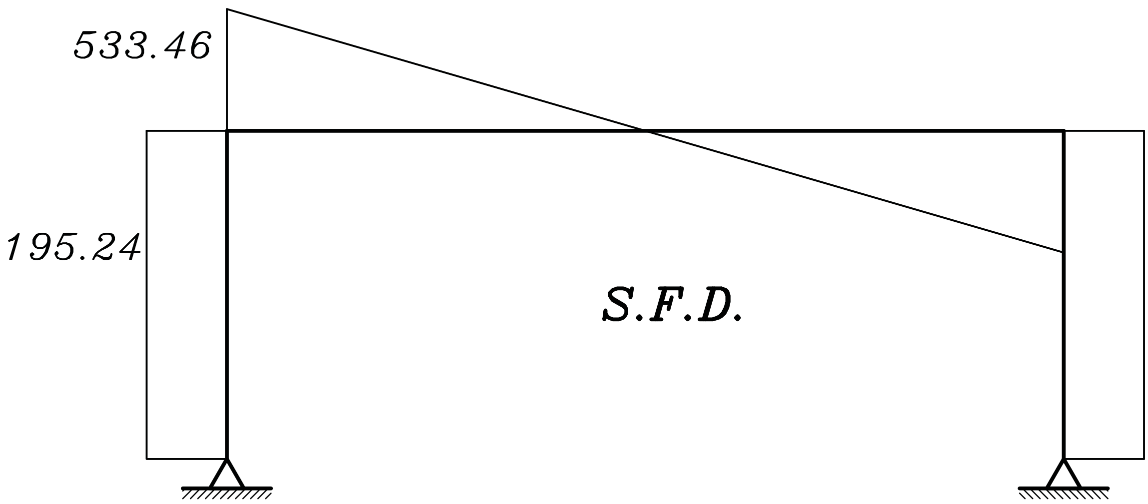
$I_{b2} = 0.11m^4$

$I_{b1} = 0.3*\frac{1.5^3}{12} = 0.084m^4$

$I_{av.} = \frac{0.11*16 + 0.084*4}{20} = 0.10m^4$

$$D.f_{ab} = \frac{0.75*(0.049/7)}{0.75(\frac{0.049}{7})+0.5(\frac{0.11}{20})} = 0.68$$





Sec(1−1)

$$\frac{N_u}{bt\ f_{cu}}=\frac{594.16*10^3}{300*1500*25}=0.053>0.04 (Don't\ \ neglect\ \ N)$$

$$e=\frac{M}{N}=\frac{1366.67}{594.16}=2.3m$$

$$\frac{e}{t}=\frac{2.3}{1.5}=1.5>0.5\ \ (big\ \ eccentricity)$$

$$e_s=e+\frac{t}{2}-c=2.3+\frac{1.5}{2}-0.1=2.95m$$

$$M_{us}=N*e_s=594.16*2.95=1752.87kN.m$$

$$1400=C_1\sqrt{\frac{1752.87*10^6}{300*25}}\quad C_1=2.90\quad J=0.73$$

$$A_s=\frac{1752.87*10^6}{0.73*1400*360}-\frac{594.16*10^3}{(360/1.15)}=28.58cm^2$$

8ø22

Sec. (2−2)

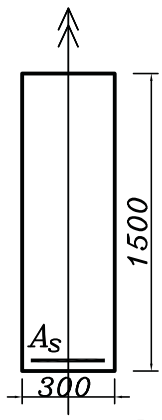
$$\frac{N}{bt\ f_{cu}}=\frac{195.24*10^3}{300*1500*25}=0.017<0.04\ \ (neglect\ \ N)$$

$$1400=C_1\sqrt{\frac{1366.67*10^6}{300*25}}\quad C_1=3.28\quad J=0.77$$

$$A_s=\frac{1366.67*10^6}{0.77*1400*360}=35.37cm^2$$

10ø22

Sec. (3−3)



R−Sec $b=300mm$, $d=1400mm$

, $M_{ul}=1698.81kN.m,\quad N_{u.l.}$ (neglected)

لاحظ أن $Sec(3-3)$ هو $(R-Sec)$ صريح

$$1400 = C_1 \sqrt{\frac{1698.81*10^6}{300*25}} \qquad C_1 = 2.94 \qquad J = 0.74$$

$$A_s = \frac{1698.81*10^6}{0.74*1400*360} = 45.76 cm^2$$

10ø25

Check Shear

$$Q_{cr} = Q_{max} - w\left(\frac{c}{2} + \frac{d}{2}\right)$$

$$Q_{cr} = 533 - 26.2\left(\frac{1.50}{2} + \frac{1.40}{2}\right)$$

$$Q_{cr} = 495 \ kN$$

$$q_{su} = \frac{Q_{cr}}{bd} = \frac{495*10^3}{300*1400} = 1.18 \ N/mm^2$$

$$q_{cu} = 0.24\sqrt{\frac{25}{1.5}} = 0.98 \ N/mm^2$$

$$q_{cu} < q_u < q_{umax}$$

$$q_{max} = 0.7\sqrt{\frac{25}{1.5}} = 2.86 \ N/mm^2$$

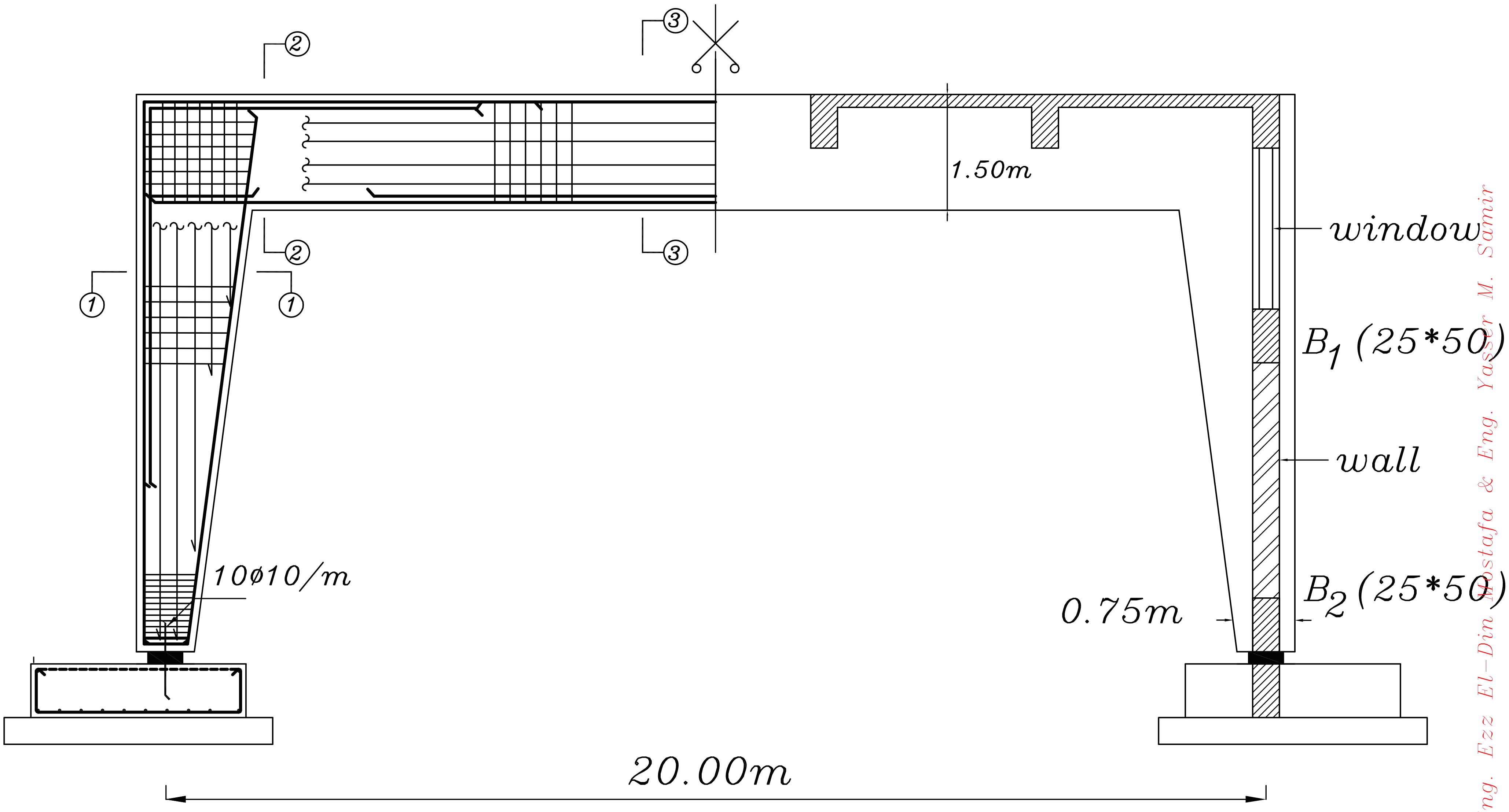
$$q_u - \frac{q_{cu}}{2} = \frac{n A_s f_y / \gamma_s}{bS}$$

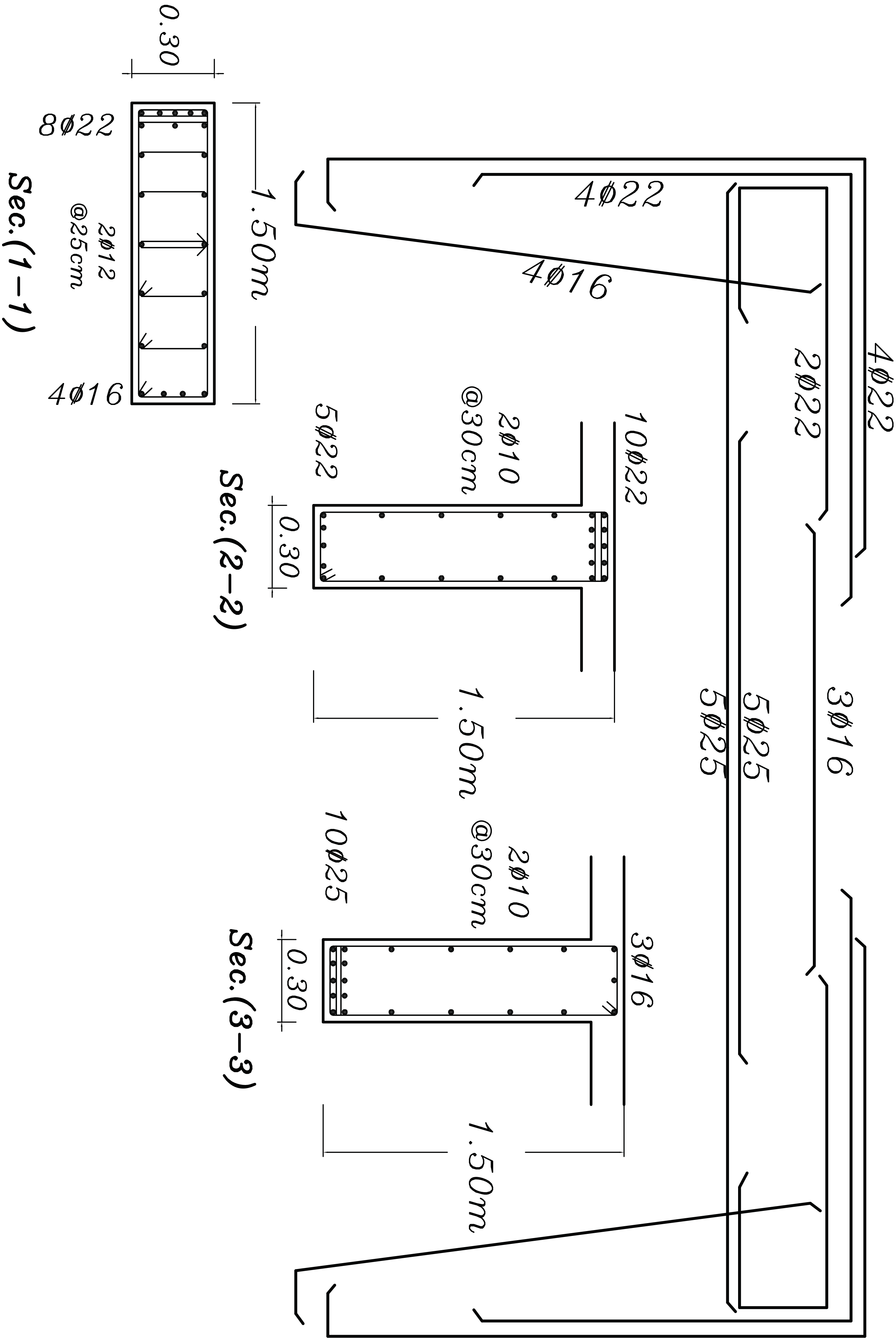
assume $n = 2$ $\qquad A_s = 78.5 mm^2 = \phi 10$

$$1.18 - \frac{0.98}{2} = \frac{2*78.5*240/1.15}{300*S} \longrightarrow S = 158mm$$

$$No.of \ stirrups/m' = \frac{1000}{S} = 6.3$$ **Take Stirrups 7ø10/m'**

R.F.T. of the Frame




0.30
8ϕ22
1.50m
2ϕ12
@25cm
4ϕ16
Sec.(1-1)
4ϕ22
4ϕ16
2ϕ22
4ϕ22
10ϕ22
2ϕ10
@30cm
5ϕ22
0.30
Sec.(2-2)
1.50m
5ϕ25
5ϕ25
3ϕ16
10ϕ25
2ϕ10
@30cm
3ϕ16
0.30
Sec.(3-3)
1.50m

Example

For the given plan and cross– section,
it is required to:

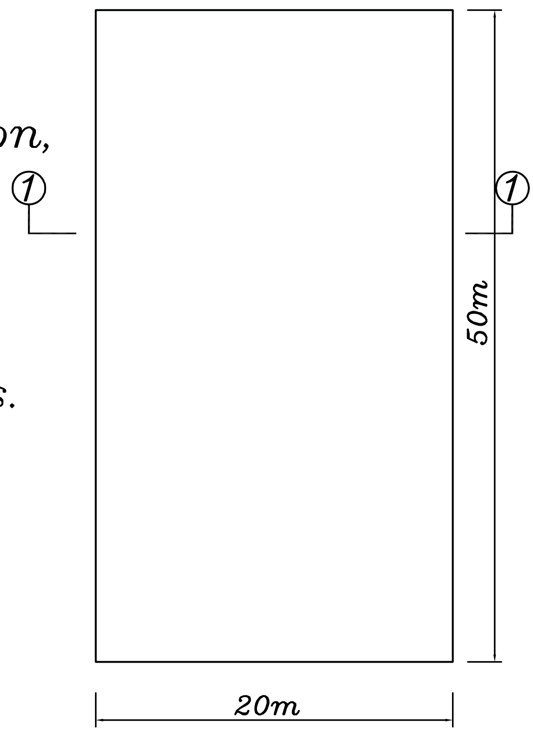
1– Draw structural plan and cross section to show all concrete elements.

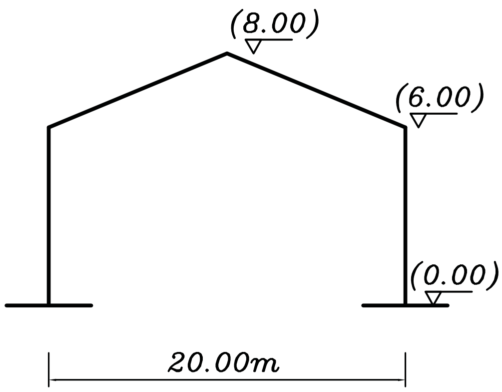
2– Design the slabs and Main supporting element.

given Use Sec. Beams 25*50

$f_{cu}=25N/mm^2$ $f_y=360N/mm^2$

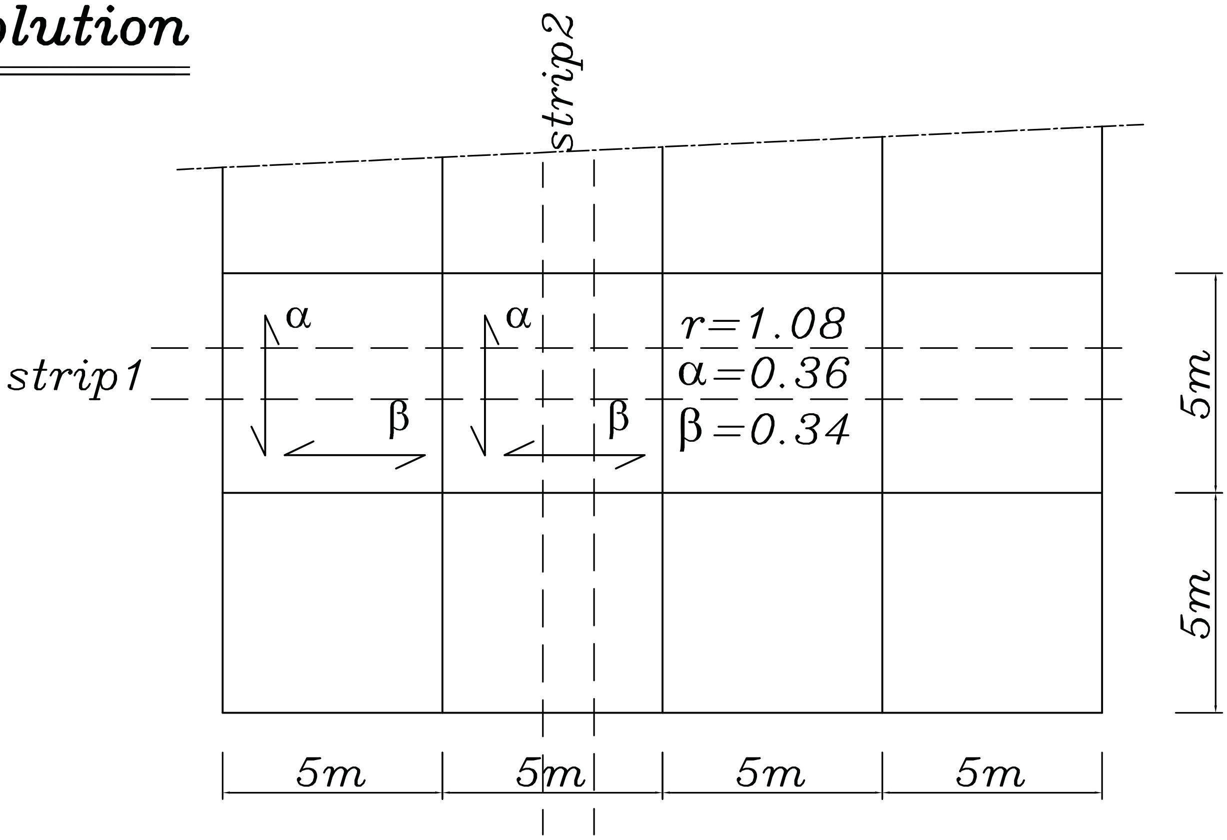
$F.C.=1.5kN/m^2$ $L.L.=1.0kN/m^2$

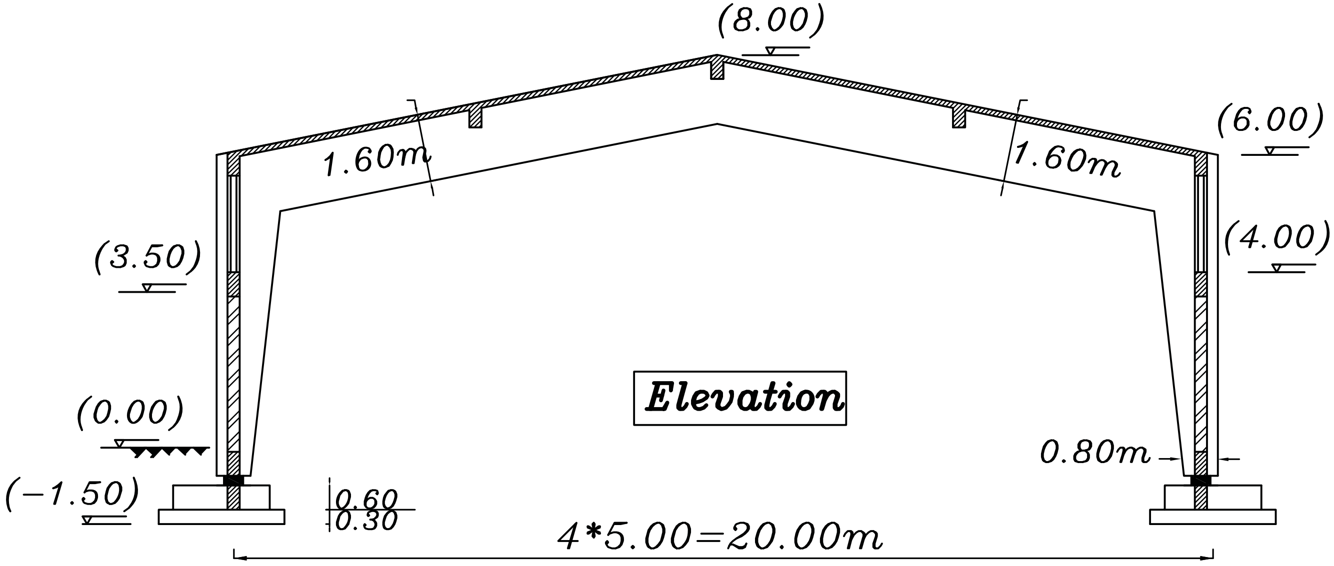


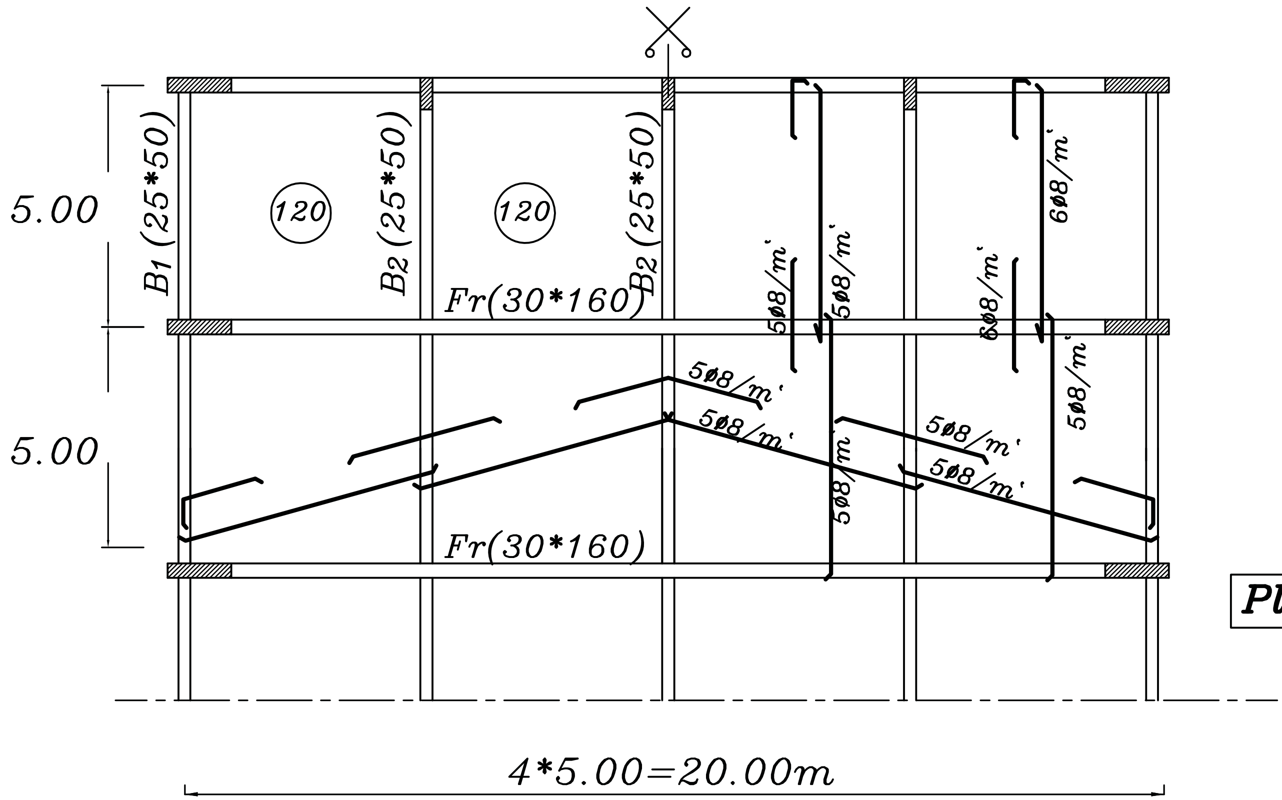


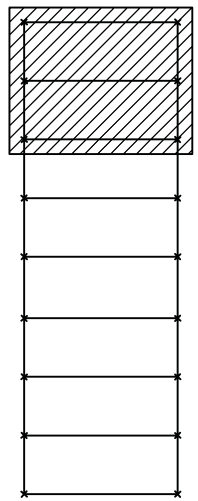
Sec.(1–1)

Solution









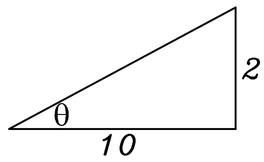
KEY PLAN

1:200 ⟶ 1:400

1- Design of slabs

$$t_s = \frac{500}{45} = 11.11cm$$

Take $t_s = 12cm$ For all slabs



$$\theta = tan^{-1}(\frac{2}{10})$$

$$\theta = 11.31$$

$$Cos\,\theta = 0.98$$

$$w_{su} = 1.4[t_s \gamma_c + F.c.] + 1.6\ \ L.L.Cos\theta$$

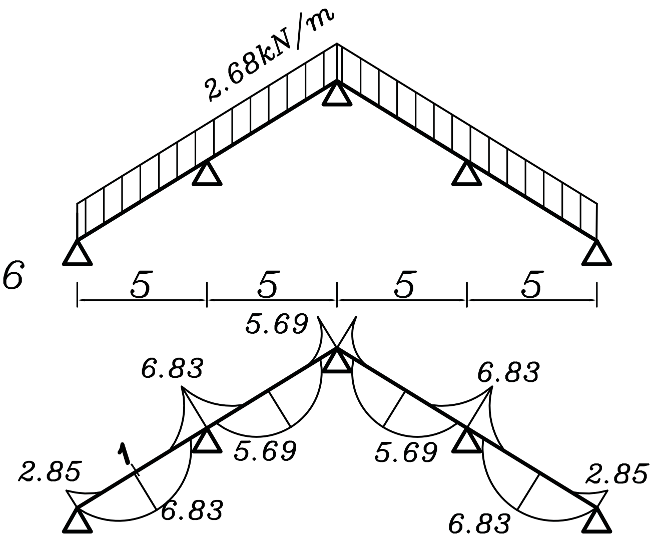
$$w_{su} = 1.4[0.12*25 + 1.5] + 1.6*1.0*0.98$$

$$\boxed{w_{su} = 7.87\ \ kN/m^2}$$

Strip(1)

Sec. (1-1)

$d = 120 - 30 = 90\ \ mm$

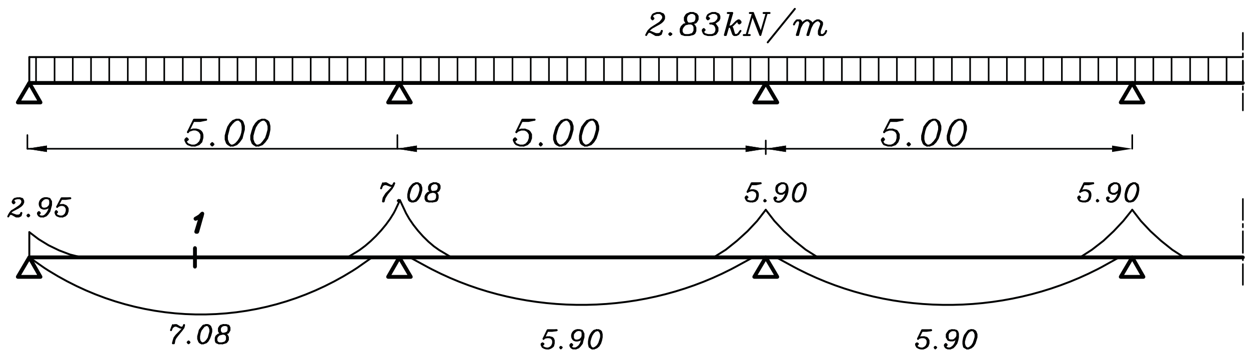


$$90 = C_1\sqrt{\frac{6.83*10^6}{1000*25}} \quad C_1 = 5.44 \quad J = 0.826$$

$$A_s = \frac{6.83*10^6}{0.826*360*90} = 255mm^2/m'$$

$$A_s = 5\phi 8/m'$$

Strip(2)



Sec. (1-1)

$d = 120 - 20 = 100\ \ mm$

$$100 = C_1\sqrt{\frac{7.08*10^6}{1000*25}} \quad C_1 = 5.3 \quad J = 0.826$$

$$A_s = \frac{7.08*10^6}{0.826*360*100} = 238mm^2/m'$$

$$A_s = 5\phi 8/m'$$

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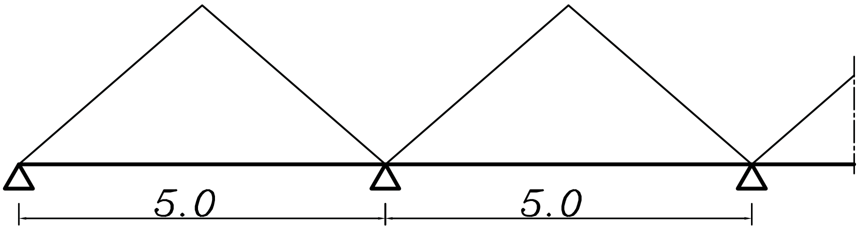
2-Analysis of Beams

For B_1

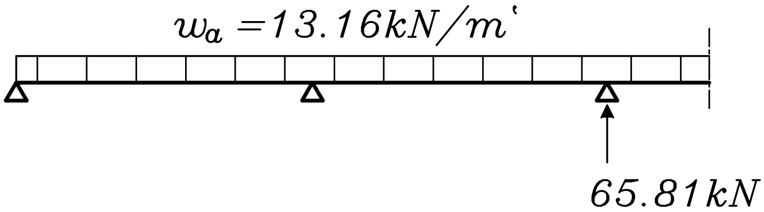


Assume beams(25*50)

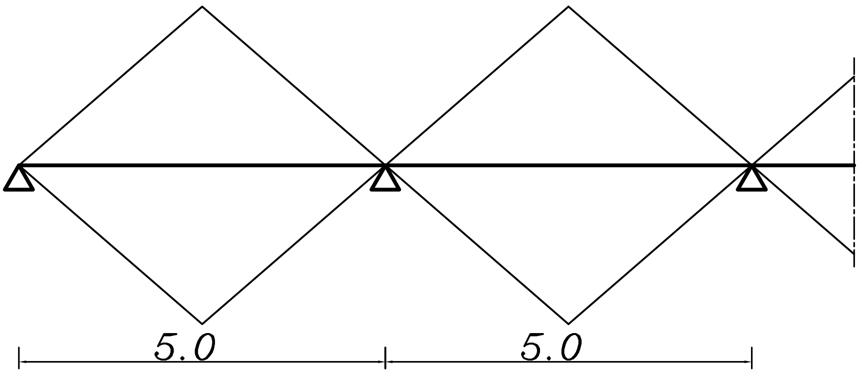
$$w_a = \gamma_c b(t - t_s)*1.40 + C_a \frac{L_s}{2} w_s$$

$$= 25*0.25[0.5-0.12]*1.40 + 0.5*\frac{5}{2}*7.87$$

$$w_a = 13.16 kN/m'$$



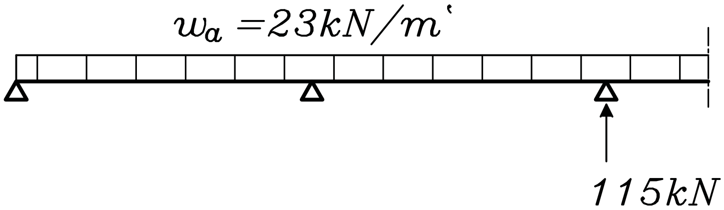
For B_2



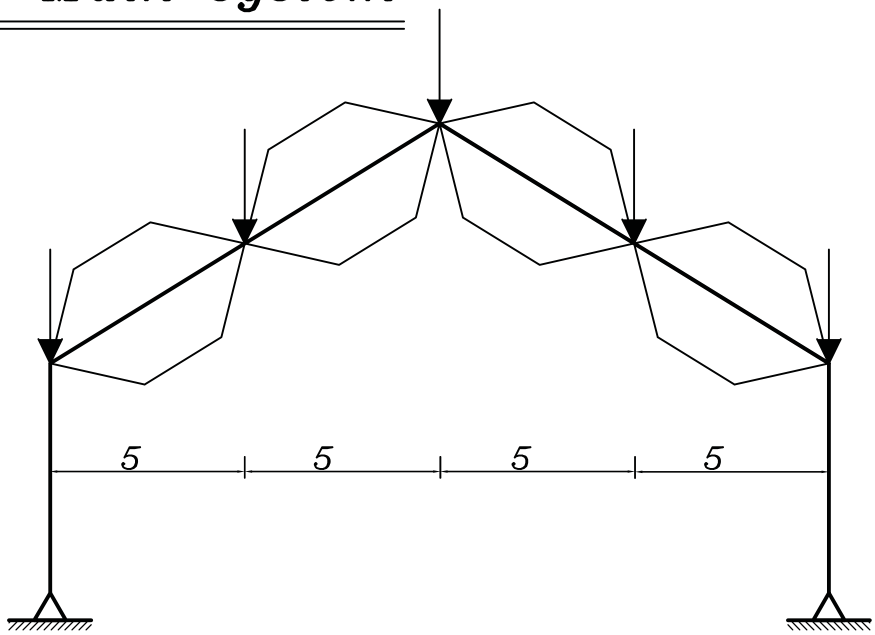
$$w_a = \gamma_c b(t - t_s)*1.40 + C_a \frac{L_s}{2} w_s *2$$

$$= 25*0.25[0.5-0.12]*1.40 + 0.5*\frac{5}{2}*7.87*2$$

$$w_a = 23 kN/m'$$



3-Analysis of Main system



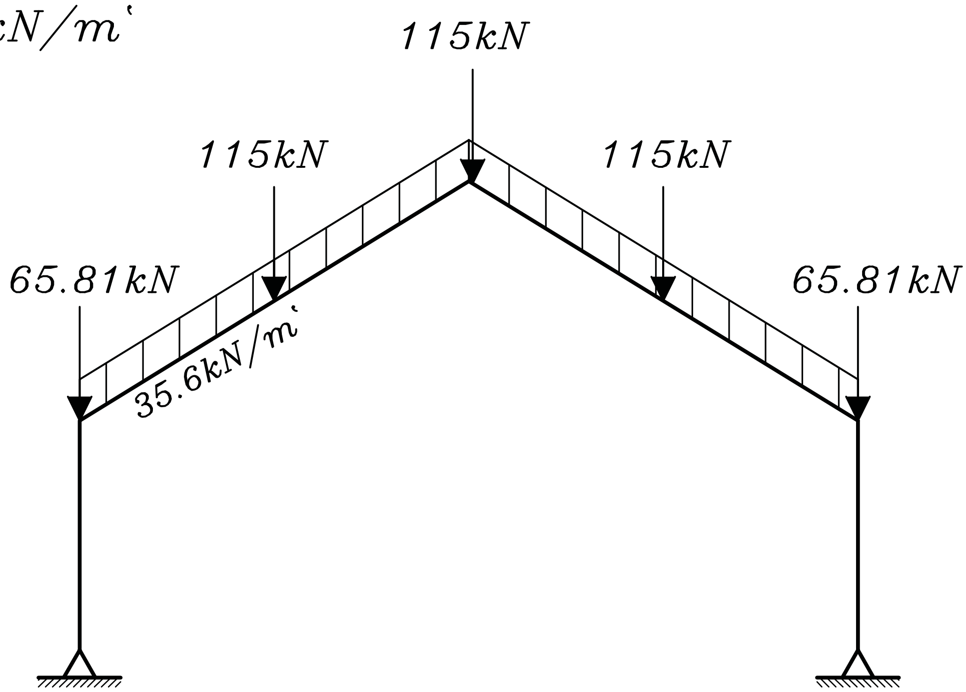
assume $b = 30cm$, $t = \frac{L}{12-14} = \frac{20}{12-14} = 1.6m$

Load For Shear = Load for Moment

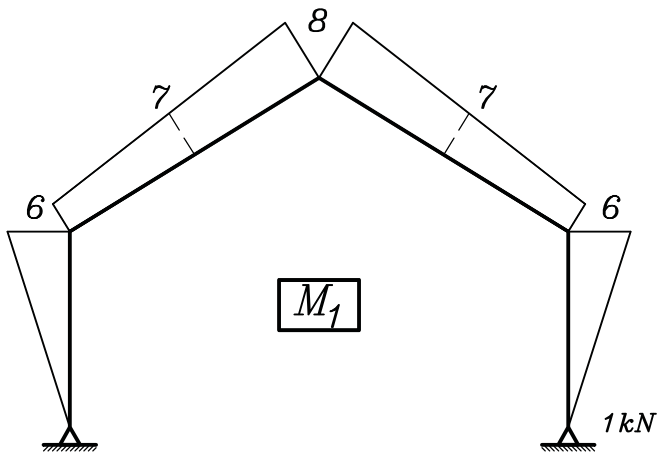
$$w_a = w_e = \gamma_c\, b(t - t_s)*1.40 + \frac{\Sigma A}{Span}\, w_s$$

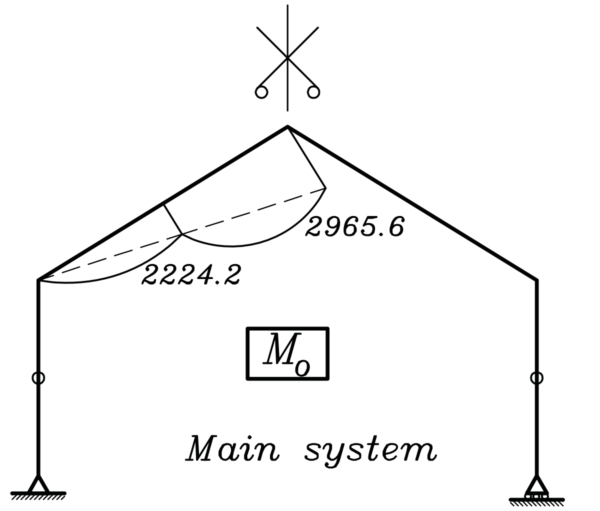
$$= 25*0.3[1.6-0.12]*1.40 + \frac{6.50*8}{20.4}*7.87$$

$$w_a = w_e = 35.6kN/m'$$



we have to use virtual work method in this example, because if we use moment distribution , we have to make sway correction.





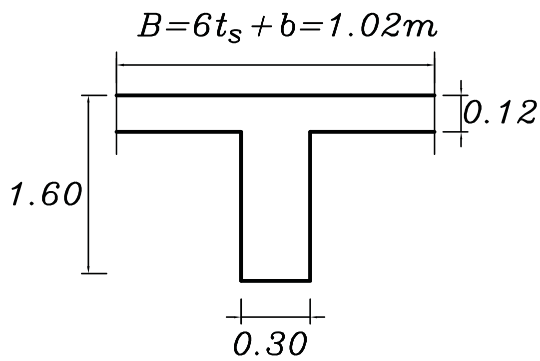
$$\delta_{10}=\frac{M_o\,M_1}{EI}$$

$$\delta_{11}=\frac{M_1^{\,2}}{EI}$$

$$I_c=\frac{0.3*(\frac{5}{6}*1.6)^3}{12}=0.059m^4$$

$$I_b=\mu B t^3*10^{-4}$$

$$=341*1.02*1.6^3*10^{-4}=0.143m^4$$



$$\frac{t_s}{t}=\frac{0.12}{1.60}=0.075$$

$$\frac{b_0}{B}=\frac{0.3}{1.02}=0.29$$

$$\delta_{10}=-\frac{1}{3}*\frac{5.10}{E_c\,I_b}[2224.2*7+2224.2*\frac{6}{2}]*2$$

$$-\frac{1}{3}*\frac{5.10}{E_c\,I_b}[2224.2*7+2965.6*8+\frac{2224.2*8}{2}+\frac{2965.6*7}{2}]*2$$

$$-\frac{2}{3}*\frac{5.10}{E_c\,I_b}[\frac{35.6*5.1*5}{8}*6.50]*2-\frac{2}{3}*\frac{5.10}{E_c\,I_b}[\frac{35.6*5.1*5}{8}7.5]*2$$

$$\delta_{10}=\frac{-1996962.567}{E_c}$$

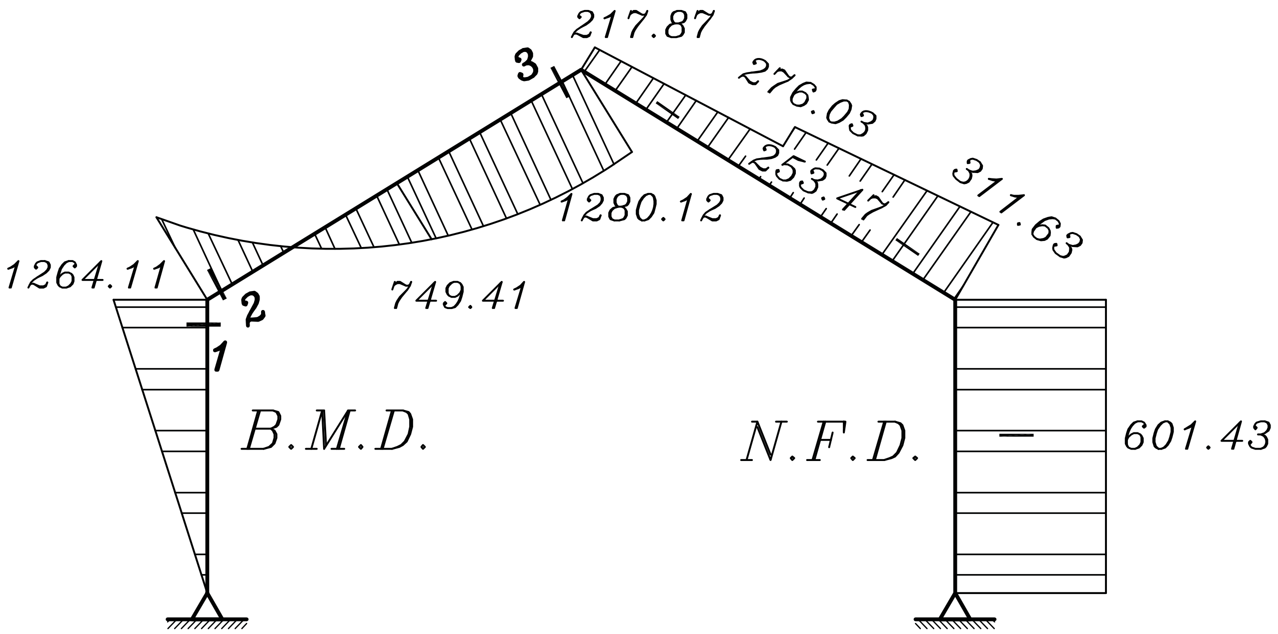
$$\delta_{11}=\frac{1}{3}*\frac{6}{E_c\,I_b}[6*6]*2+\frac{1}{3}*\frac{10.2}{E_c\,I_b}[6^2+8^2+6*8]*2$$

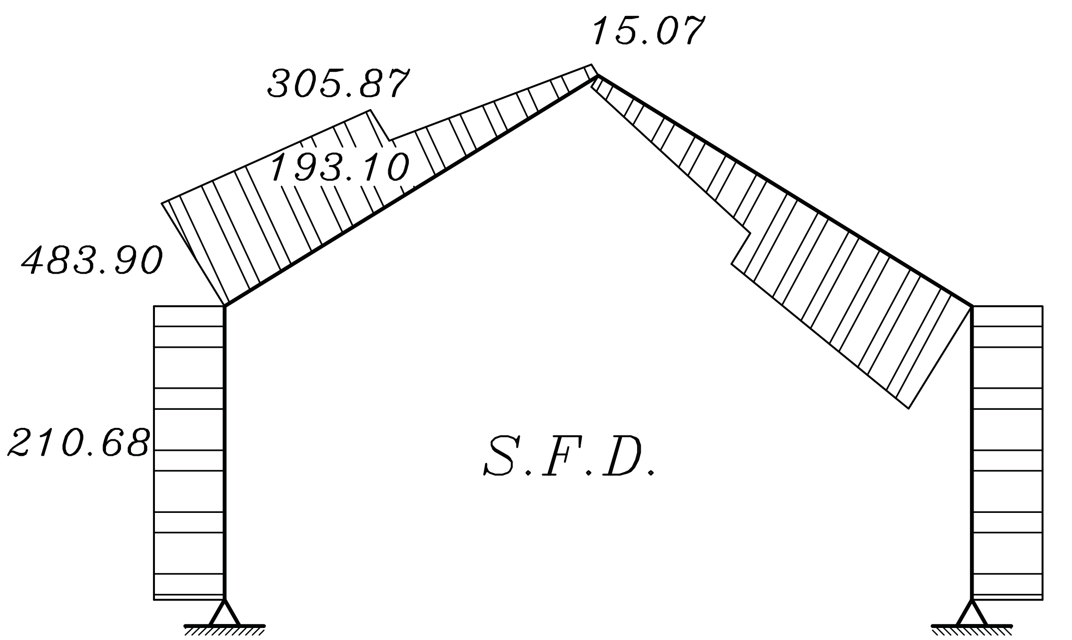
$$\delta_{11}=\frac{9478.44}{E_c}$$

$$\delta_{10} + x\,\delta_{11} = 0$$

$$-\frac{1996962.567}{E_c} + \frac{9478.44}{E_c} X = 0$$

$$\boxed{X = 210.68 kN}$$





Sec(1–1)

$$\frac{N_{u.l.}}{b\ \ t\ \ f_{cu}}=\frac{601.43*10^{3}}{300*1600*25}=0.05>0.04(\text{Don't neglect})$$

$$e=\frac{M_{u.l.}}{N_{u.l.}}=\frac{1264.11}{601.43}=2.10m$$

$$\frac{e}{t}=\frac{2.1}{1.6}=1.3>0.5(\text{big eccentricity})$$

$$e_s=e+\frac{t}{2}-c=2.1+\frac{1.6}{2}-0.1=2.80m$$

$$M_{us}=N_{u.l.}*e_s=601.43*2.80=1685.11kN.m$$

$$1500=C_1\sqrt{\frac{1685.11*10^6}{300*25}}\quad C_1=3.16\quad J=0.76$$

$$A_s=\frac{1685.11*10^6}{0.76*1500*360}-\frac{601.43*10^3}{360/1.15}=21.96cm^2$$

6ø22

Sec. (2–2)

$$\frac{N_{u.l.}}{b\ \ t\ \ f_{cu}}=\frac{311.63*10^{3}}{300*1600*25}=0.02<0.04\ (\text{neglect } N)$$

$$1500=C_1\sqrt{\frac{1264.11*10^6}{300*25}}\quad C_1=3.65\quad J=0.79$$

$$A_s=\frac{1264.11*10^6}{0.79*1500*360}=29.67cm^2$$

8ø22

Sec(3-3)

$N_{u.l.} = 217.87 kN$ (neglect N)

$M_{u.l.} = 1280.12 kN.m$

$$B = \begin{cases} 16*120+300=2220 \\ 5000 \\ \dfrac{0.76*20.4*1000}{5}+300=3400 \end{cases}$$

$B = 2220 mm$

$1500 = C_1 \sqrt{\dfrac{1220.12*10^6}{2220*25}}$ $C_1 = 9.88$ $J = 0.826$

$A_s = \dfrac{1280.12*10^6}{0.826*1500*360} = 28.70 cm^2$ **8ø22**

Check Shear

$Q_{cr} = Q_{max} - w[\dfrac{C}{2} + \dfrac{d}{2}]Cos\ \theta$

$Q_{cr} = 483.93 - 35.6[\dfrac{1.60}{2} + \dfrac{1.50}{2}]Cos\ \theta$

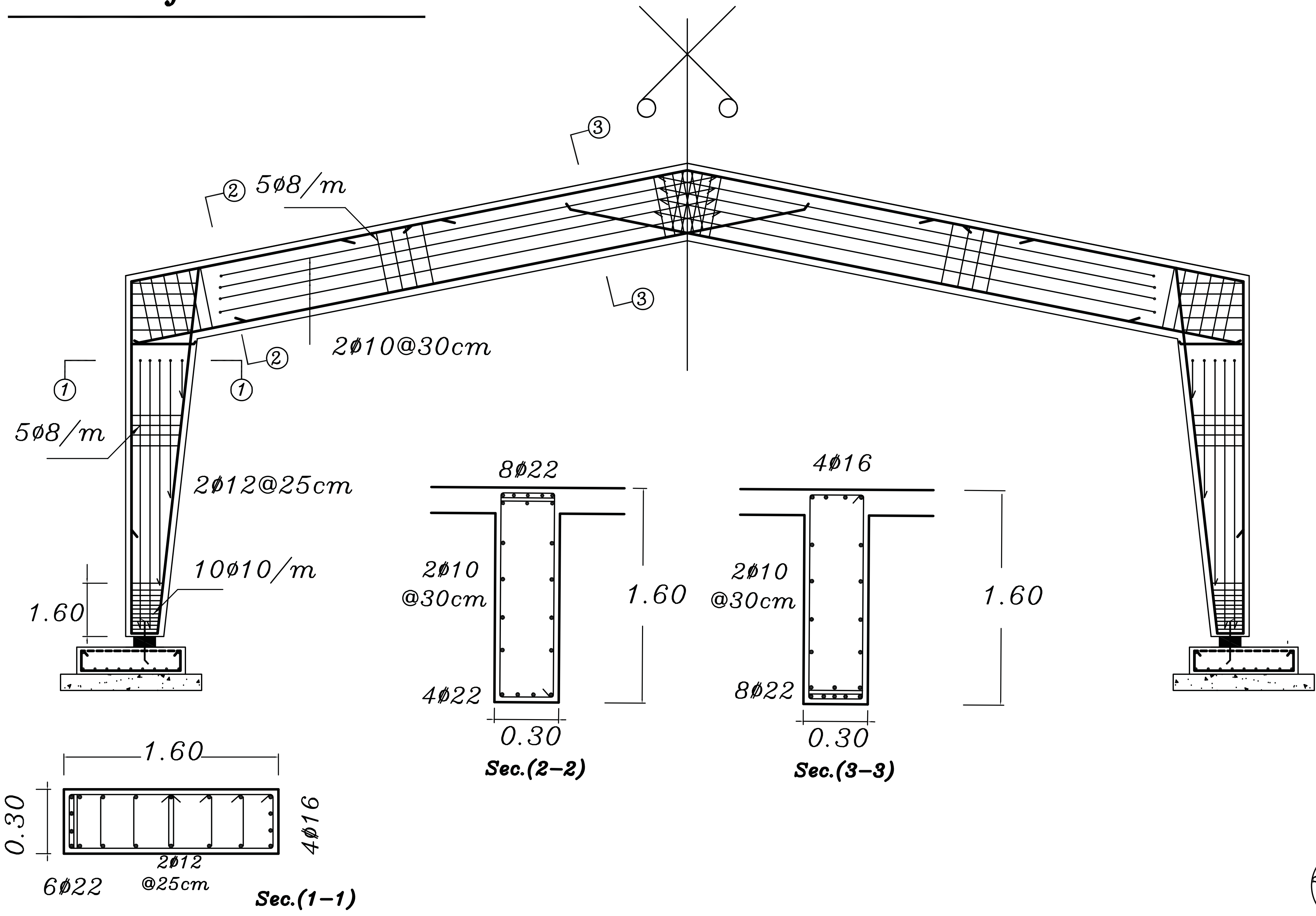
$Q_w = 429.79 kN$

$q_{su} = \dfrac{Q_{cr}}{bd} = \dfrac{429.79*10^3}{300*1500} = 0.96 N/mm^2$

$q_{cu} = 0.24\sqrt{\dfrac{25}{1.5}} = 0.98 N/mm^2$

$q_{su} < q_{cu}$ $5ø8/m'$

R.F.T. of the Frame



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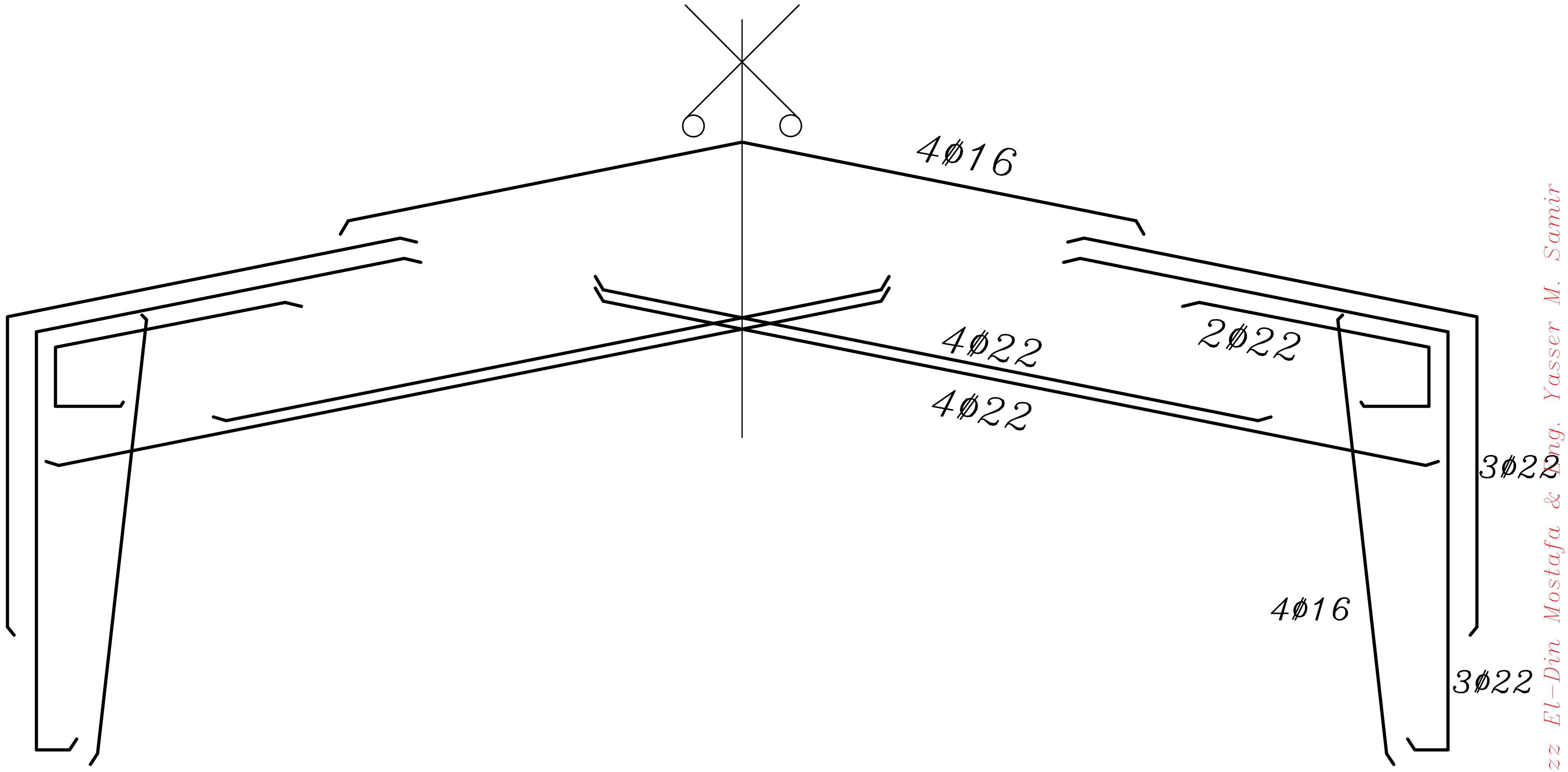
R.F.T. of the Frame



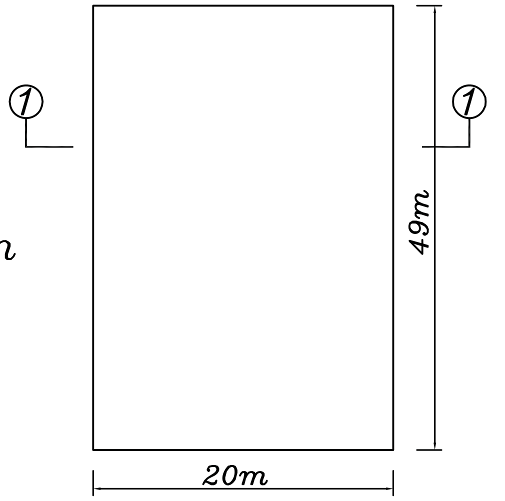
Example

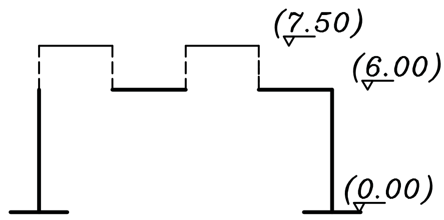
For the given plan and cross- section,

it is required to:

1- Draw structural plan and cross section to show all concrete elements.

2- Show how to solve the main system





Sec.(1-1)

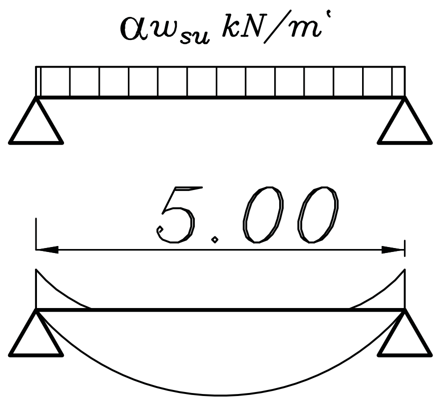
Solution

1-Design for solid slabs:

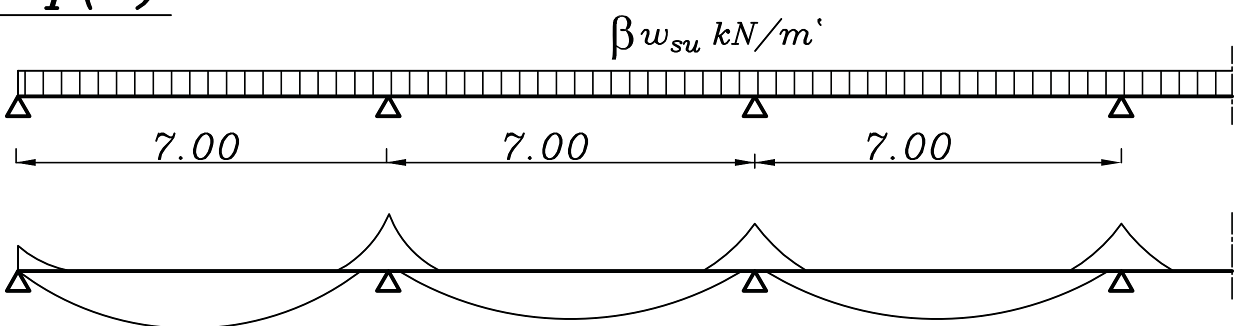
$$t_s = \frac{L_s}{20} = \frac{500}{35} = 14.2cm$$

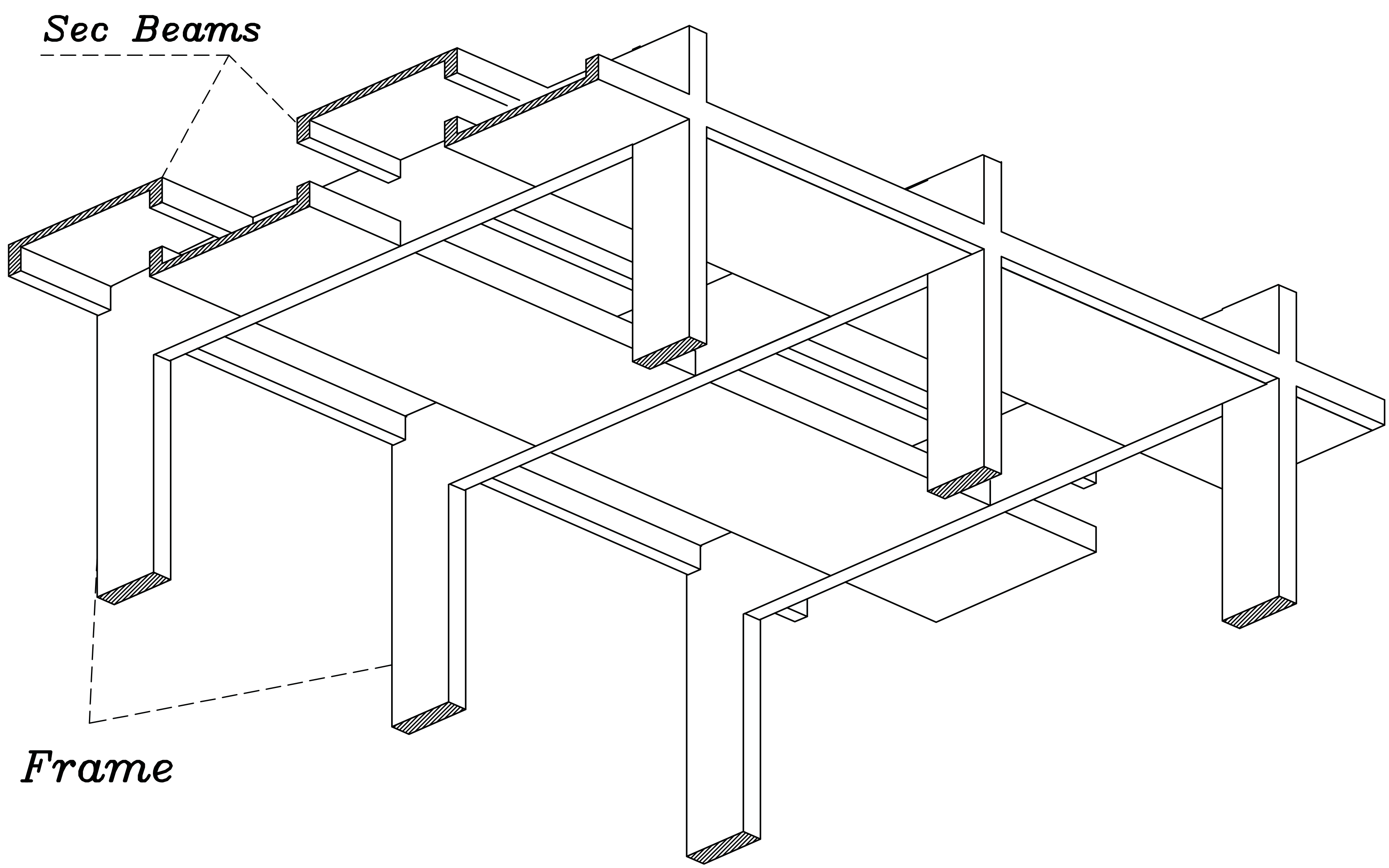
take $t_s =$ *15cm for all slabs (check deflection)*

Strip(1)

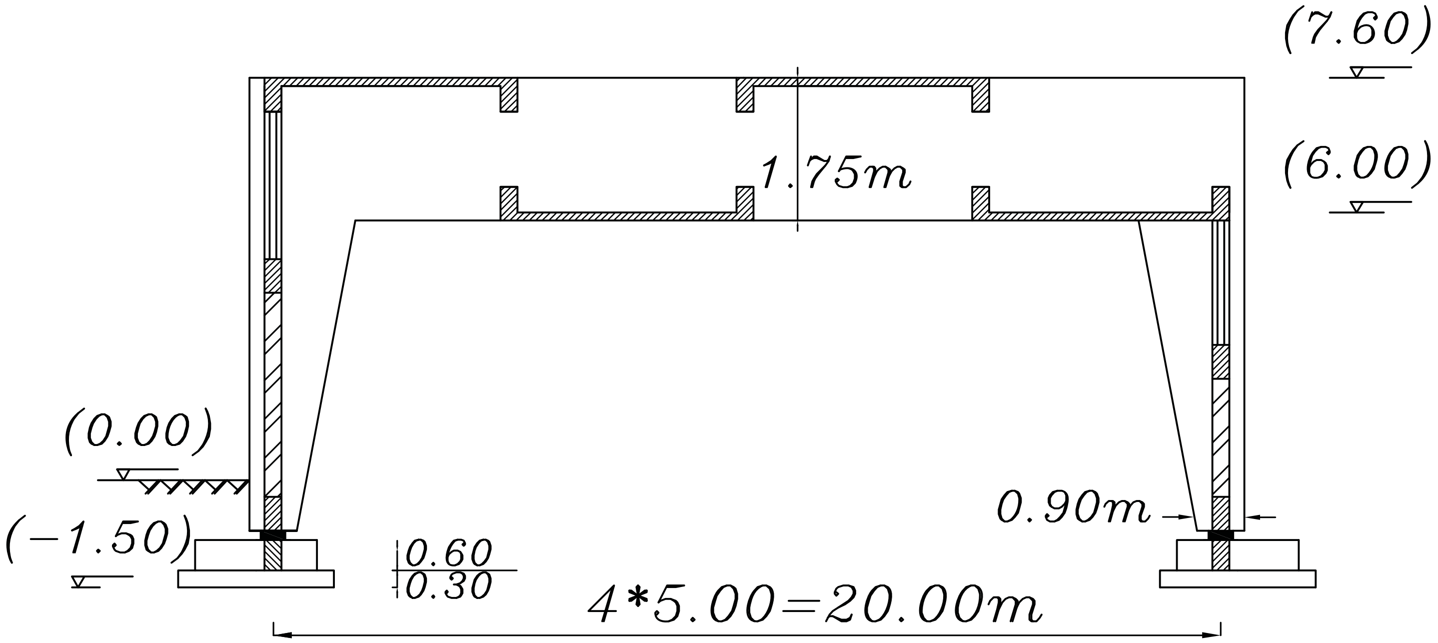


Strip(2)

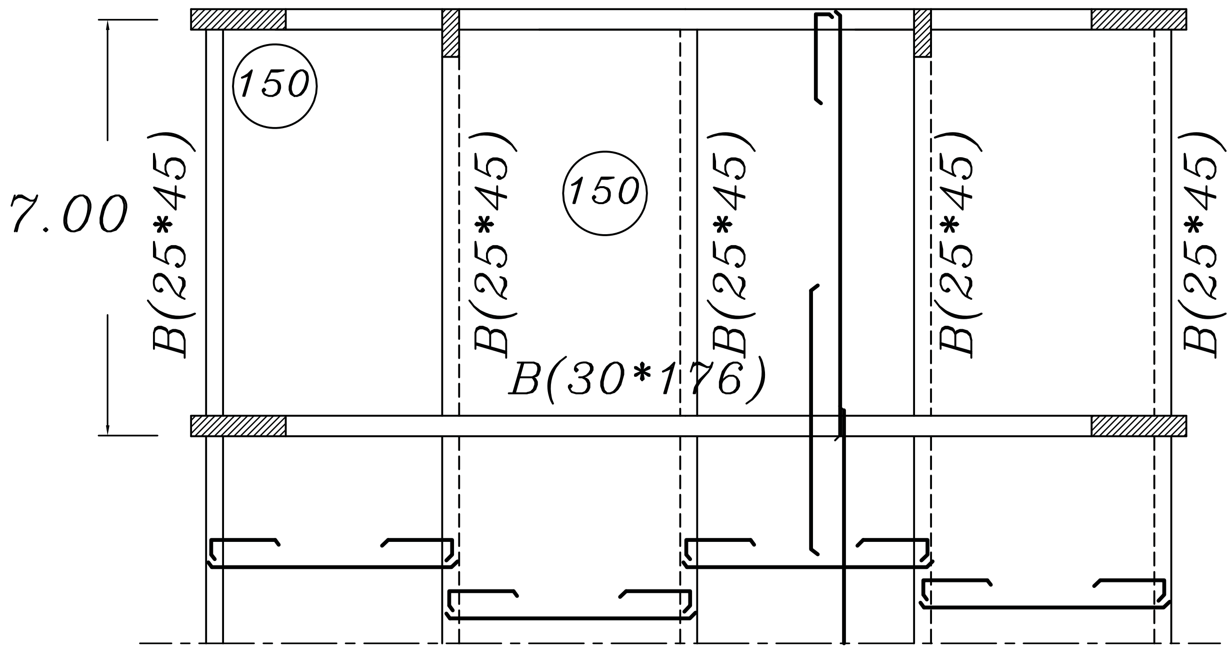




حاول تتخيل شكل البلاطات



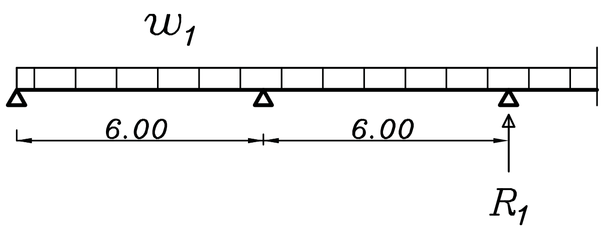
Elevation



Plan

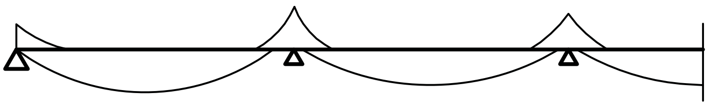
2- Design for secondary beams

For B_1



$$w_1 = \gamma_c b(t-t_s)*1.4+w_s \frac{L_s}{2}$$

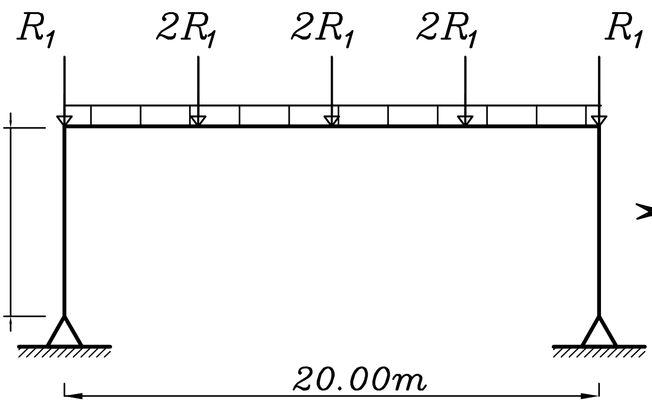
$$R_1 = w_1 * \text{Spacing}$$

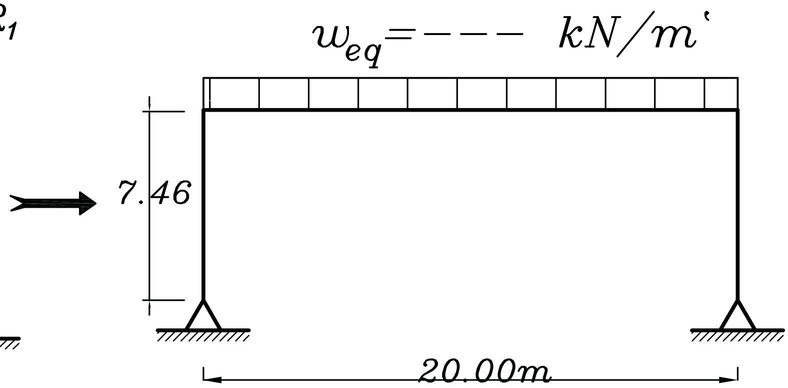


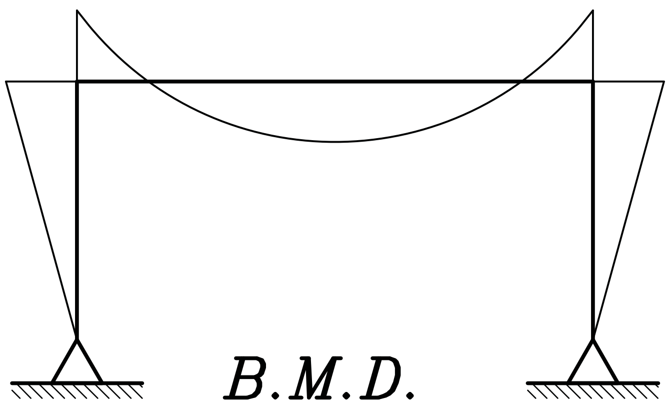
3-Design of Main System

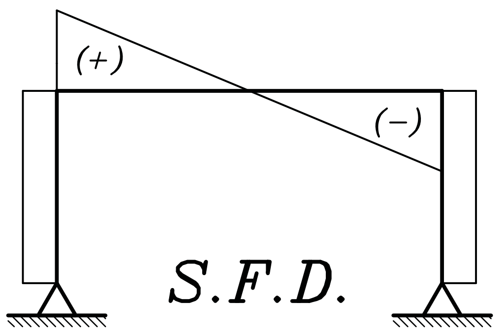
$$\text{assume} \quad b=30cm \quad , \quad t=\frac{L}{12-14}=\frac{18}{12-14}=1.40m$$

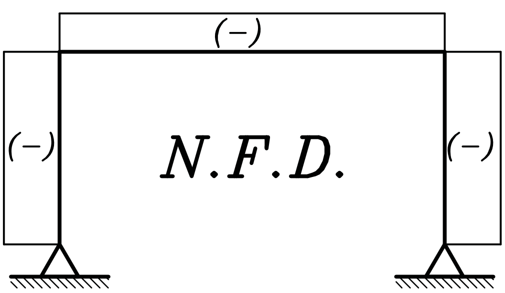
$$w_{eq}=o.w+\frac{\Sigma P}{L}$$









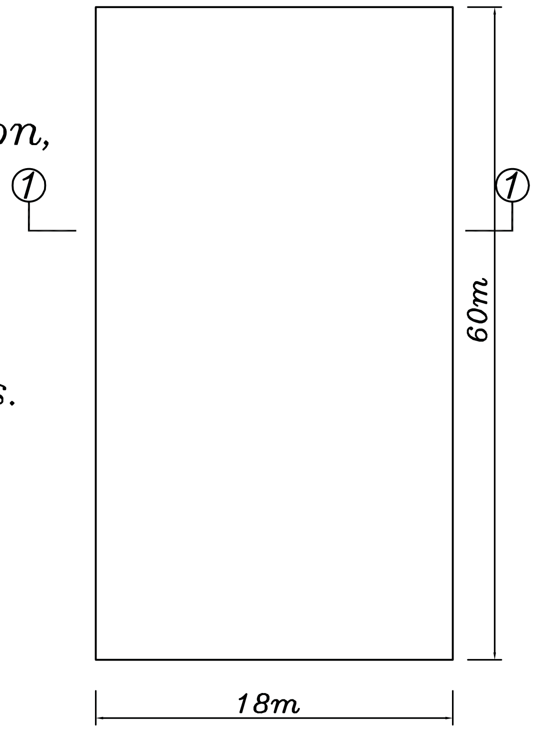


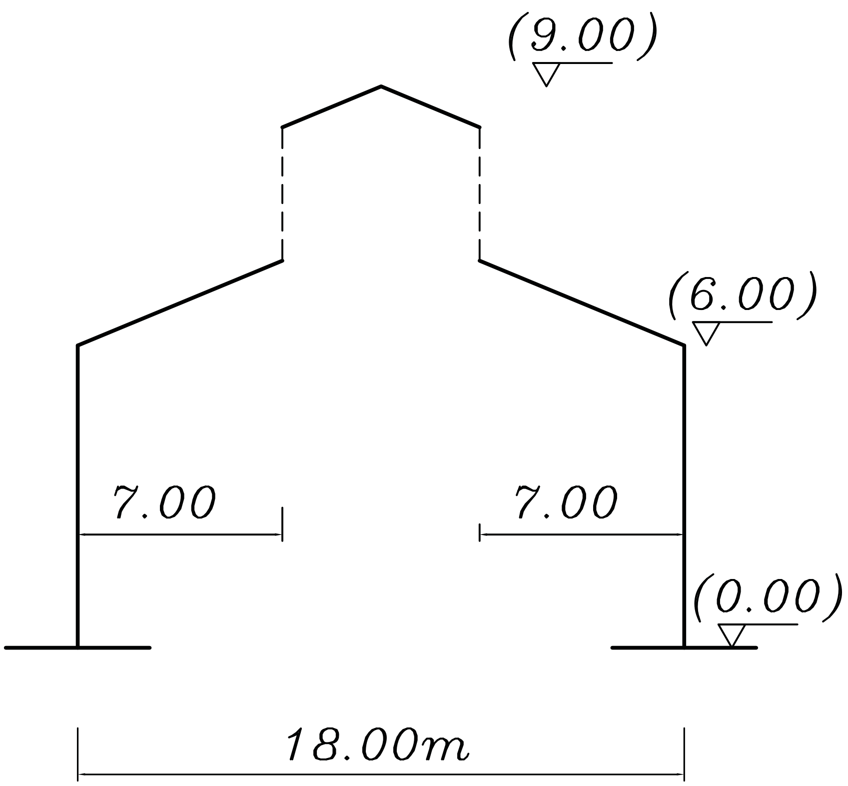
Example

For the given plan and cross- section,

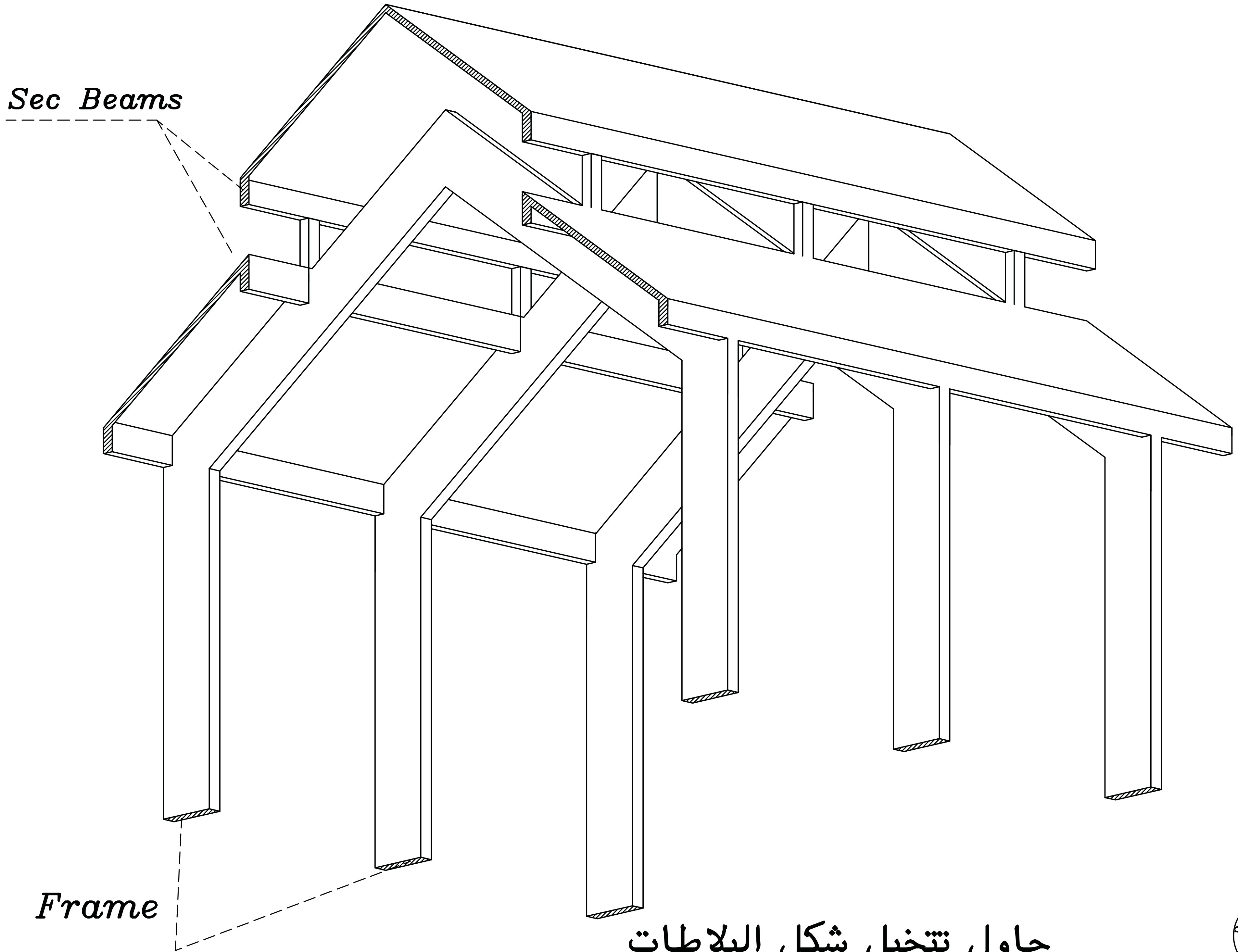
it is required to:

Draw structural plan and cross section to show all concrete elements.

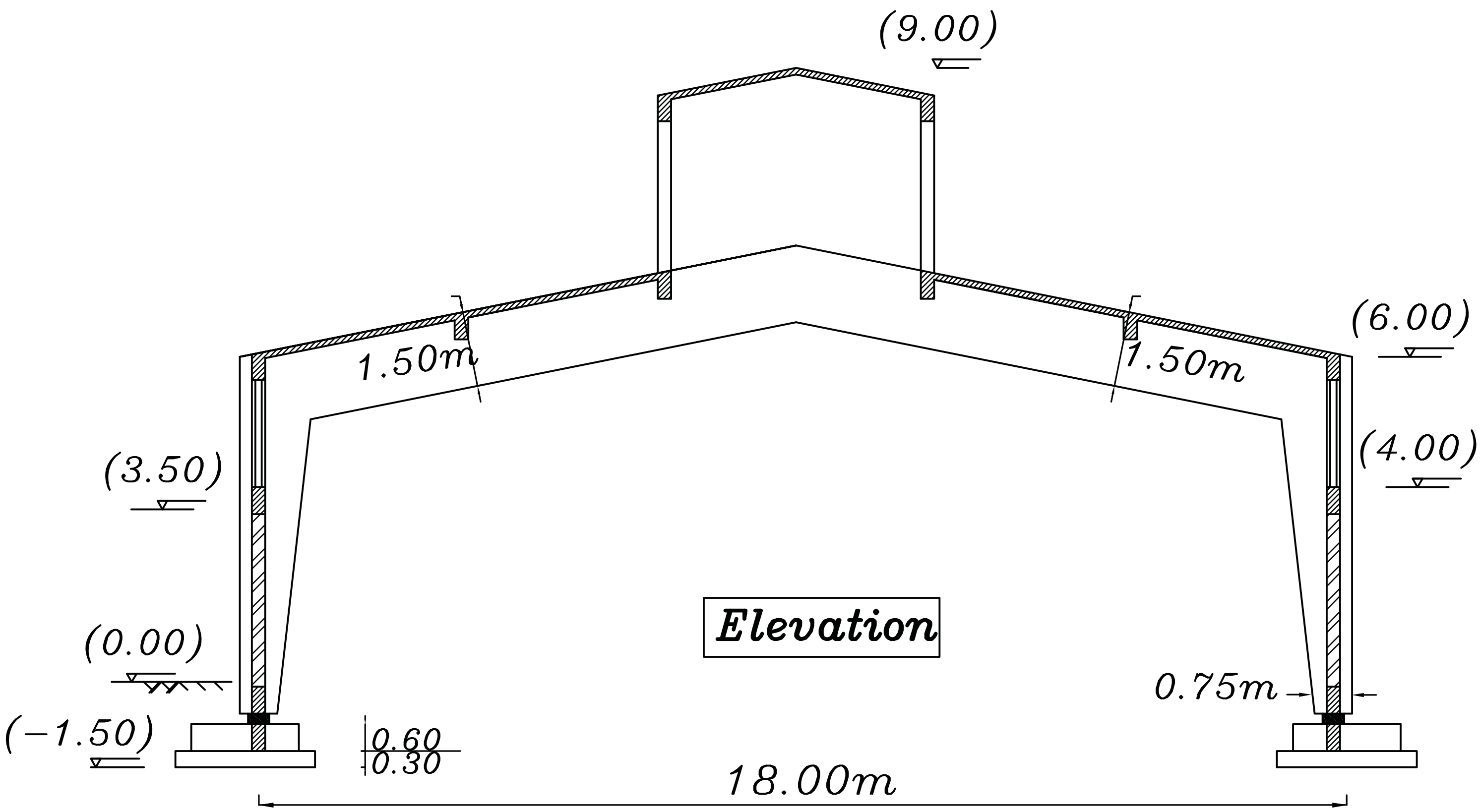


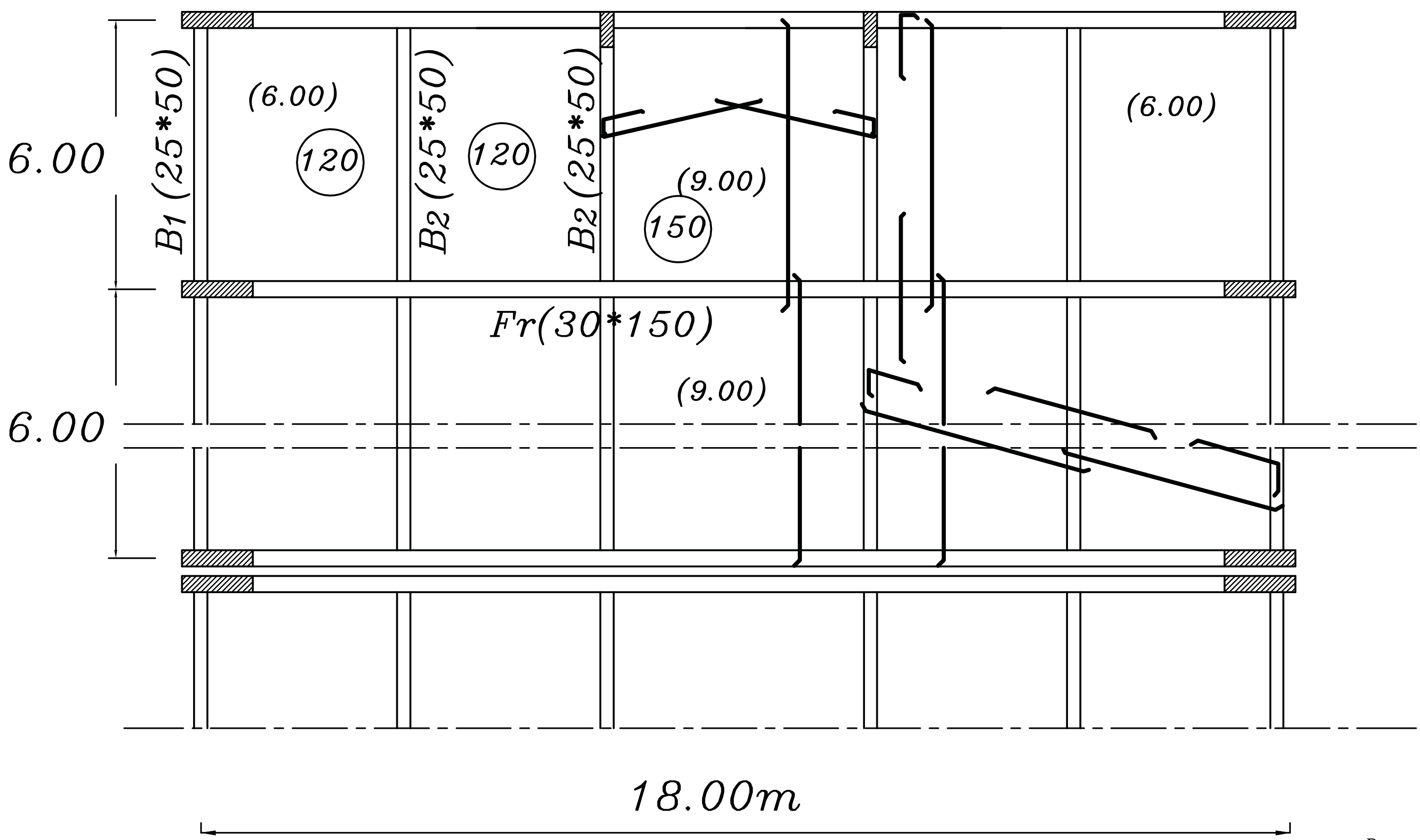


Sec.(1-1)



حاول تتخيل شكل البلاطات


(9.00)
1.50m
1.50m
(6.00)
(3.50)
(4.00)
Elevation
(0.00)
0.75m
(-1.50)
0.60
0.30
18.00m


6.00
B1 (25*50)
(6.00)
120
B2 (25*50)
120
B2 (25*50)
(9.00)
150
(6.00)
Fr(30*150)
(9.00)
6.00
18.00m

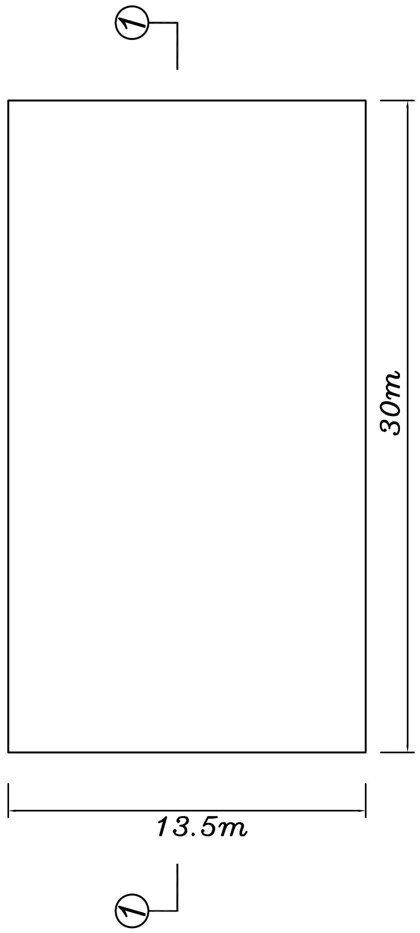
Plan

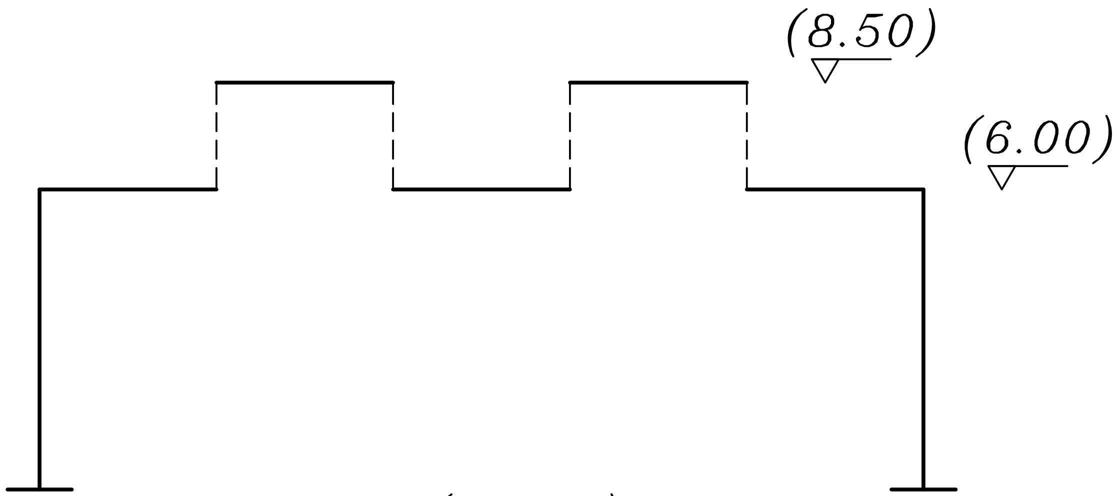
Example

For the given plan and cross- section,

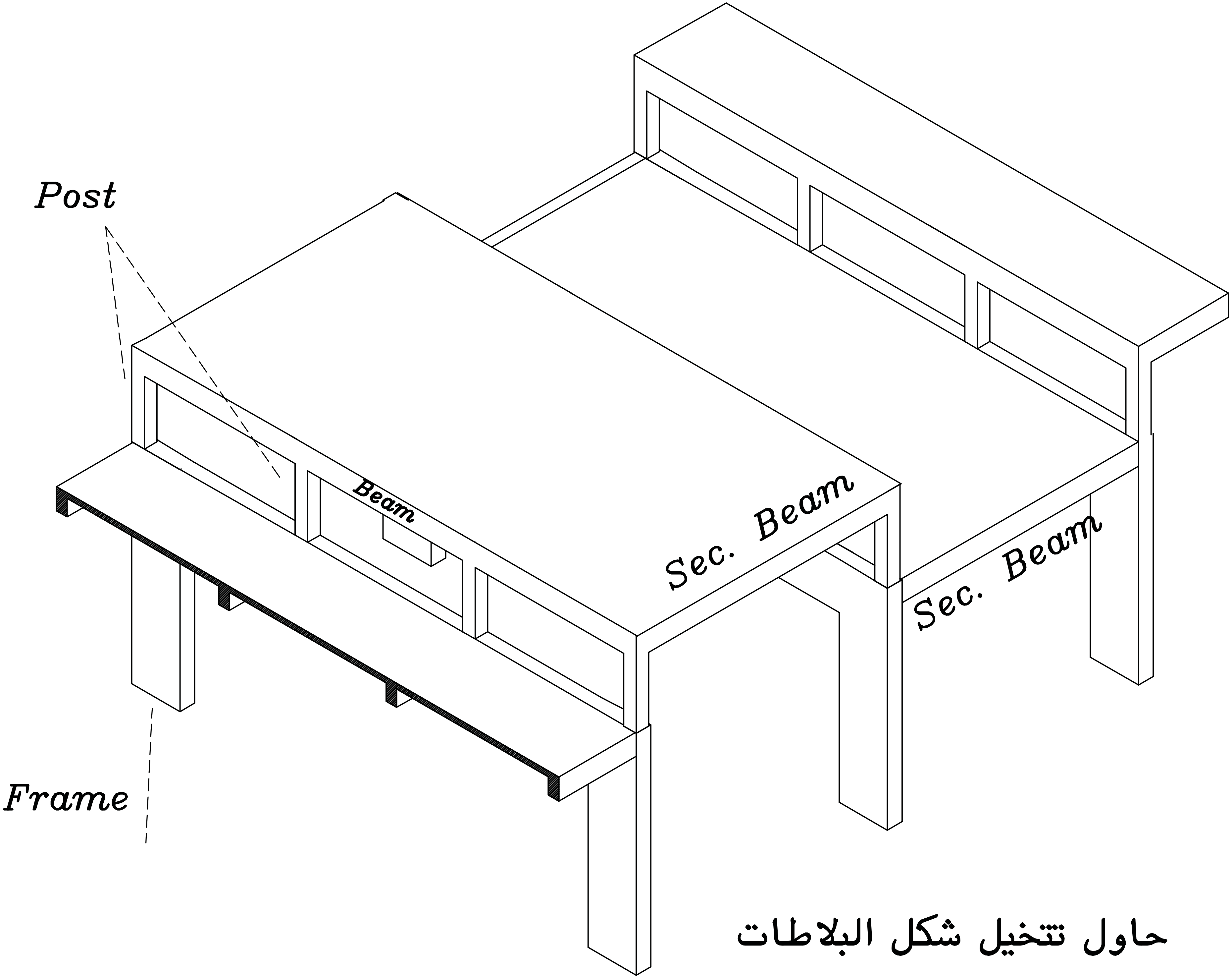
it is required to:

Draw structural plan and cross section to show all concrete elements.



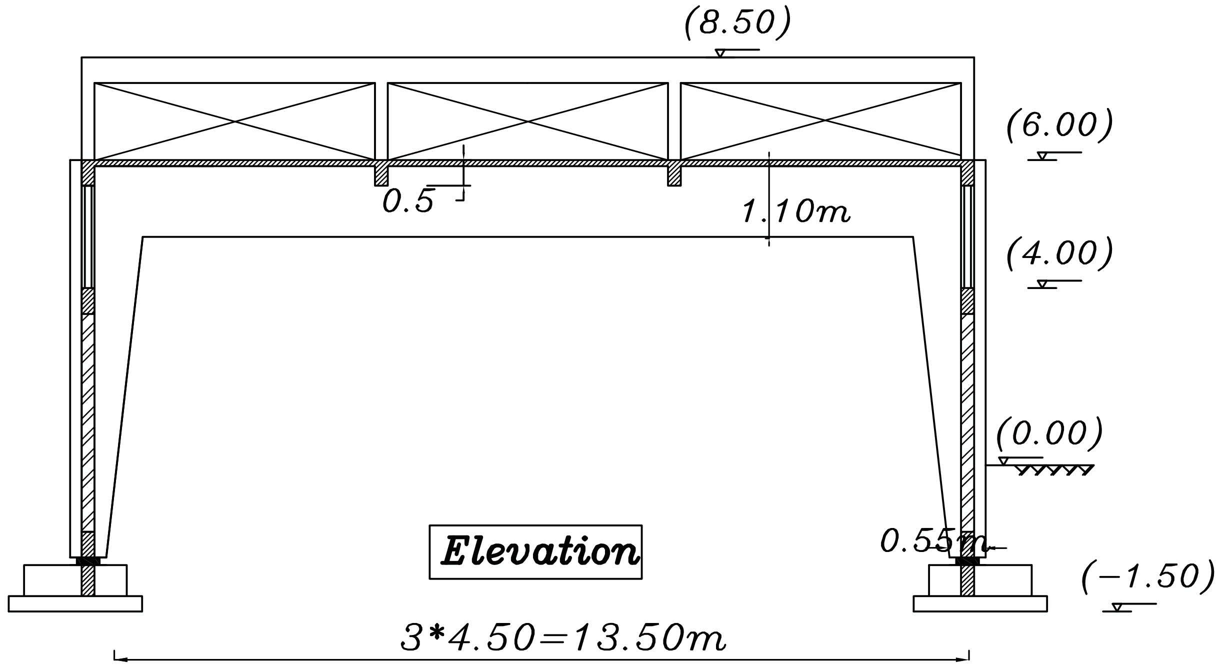


Sec.(1-1)

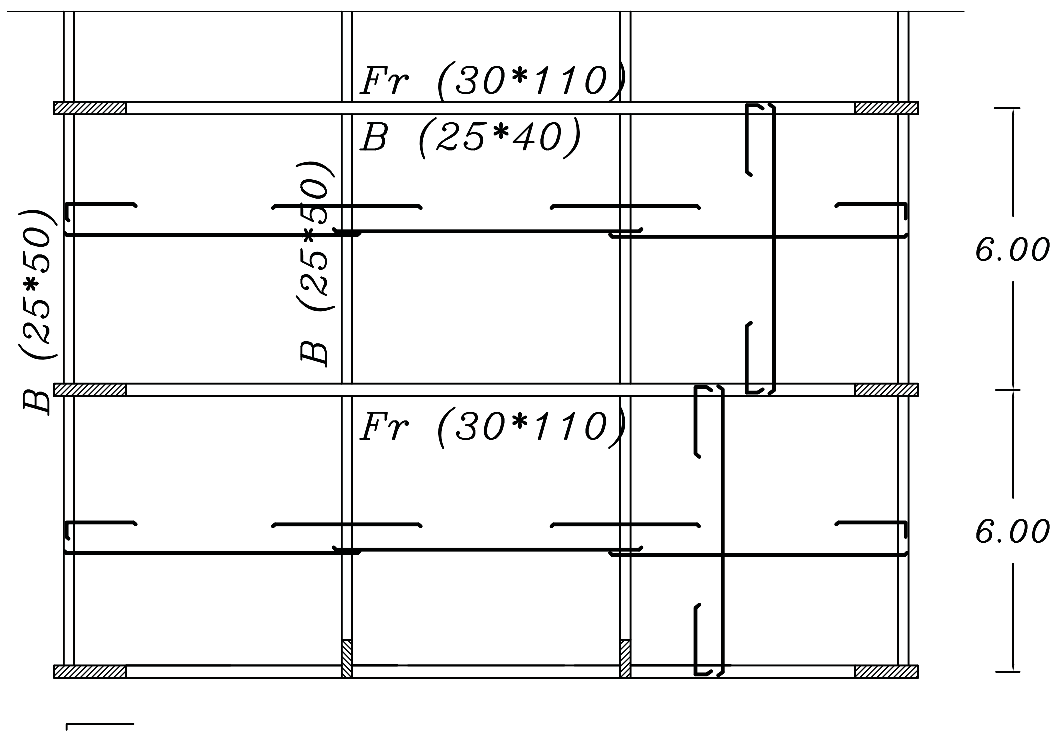


حاول تتخيل شكل البلاطات

By Eng. Ezz El-Din Mostafa & Eng. Yasser M. Samir



Elevation



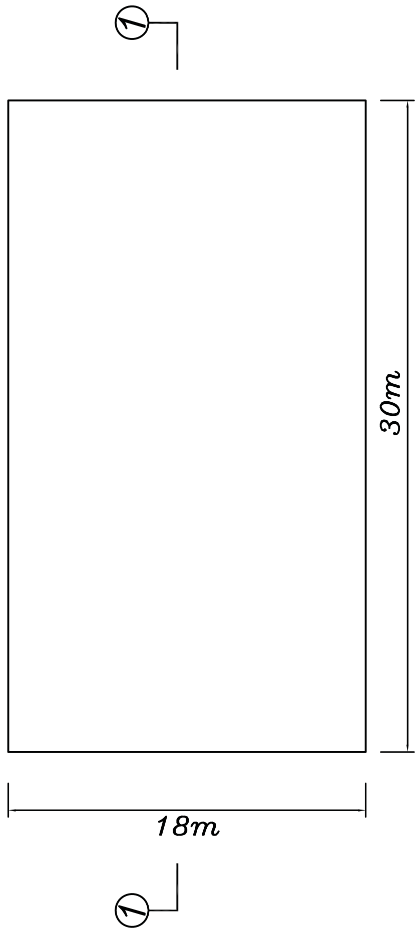
Plan

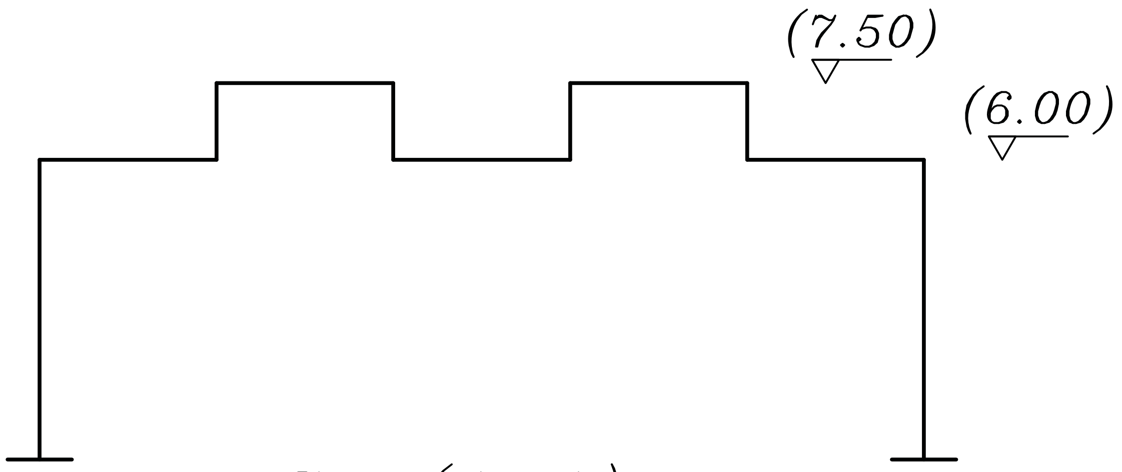
Example

For the given plan and cross- section,

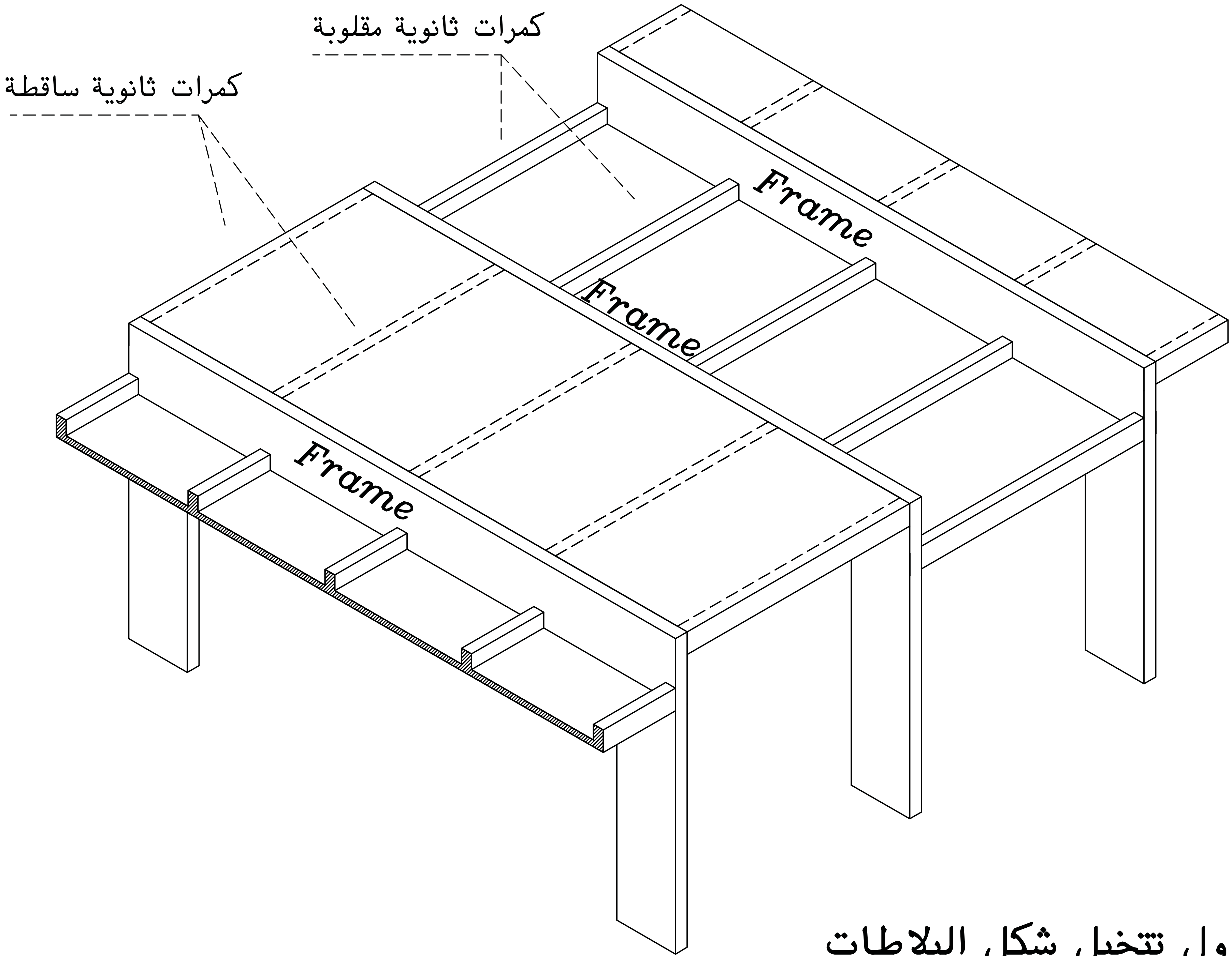
it is required to:

Draw structural plan and cross section to show all concrete elements.

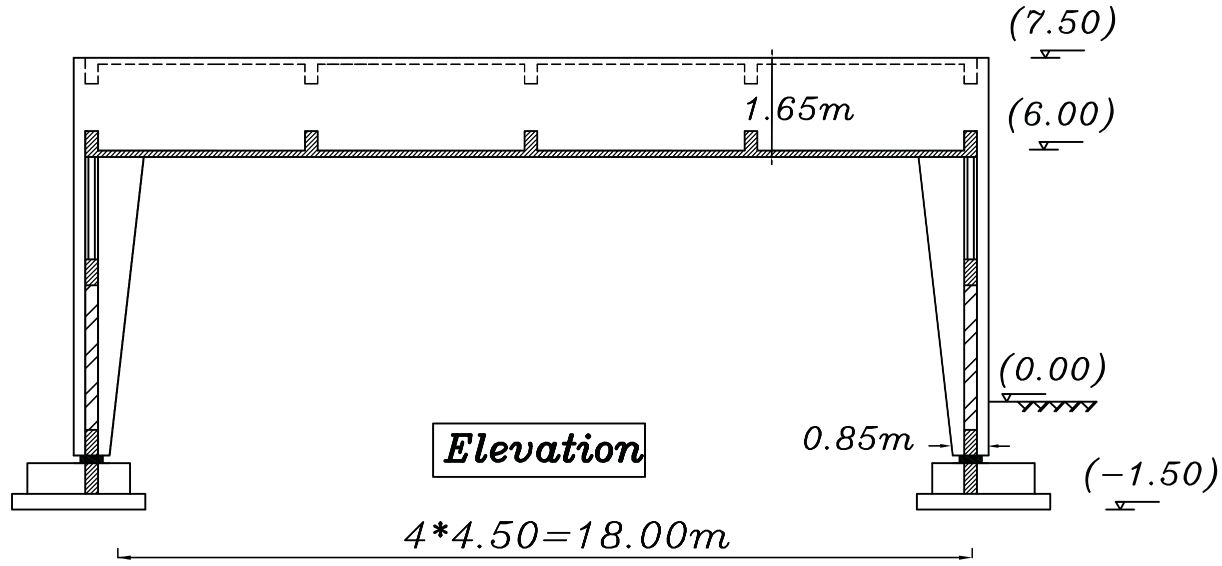




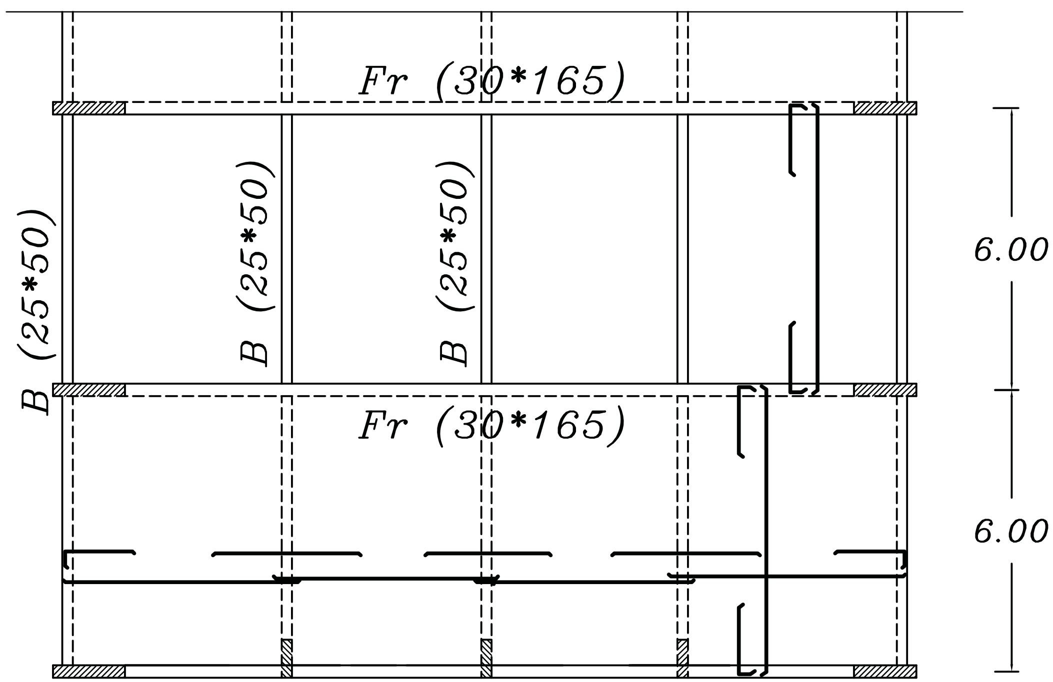
Sec.(1-1)



حاول تتخيل شكل البلاطات

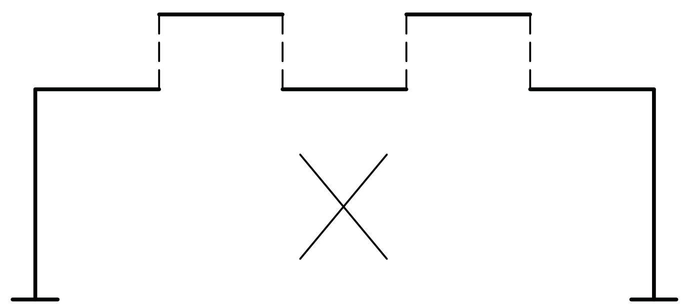


Elevation



Plan

لاحظ ان هذا الحل لا ينفع فى حالة وجود شبابيك

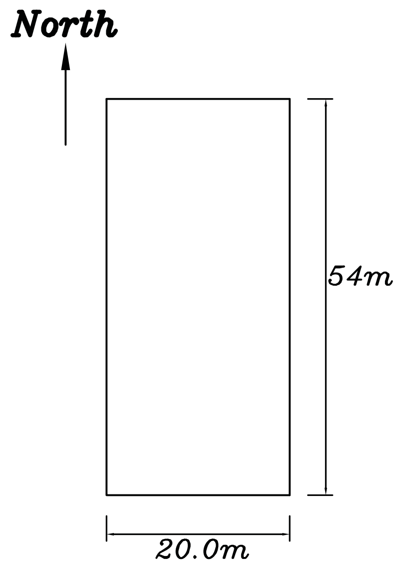


Saw Tooth Supported on a system

اذا كانت المسافة بين الاعمدة اكبر من ١٢ م فاننا نختار احد الانظمة الانشائية مثل وذلك حسب الطول القصير للارض واتجاه (Saw tooth)

Example

For the given plan, it is required to:



1-Choose the suitable system to cover this Area.

2-Design all Slabs and draw plan of Rft.

3-Design the main supporting element and draw details of Rft.

$F.C.=1.5 kN/m^2$, $L.L=0.5\ kN/m^2$

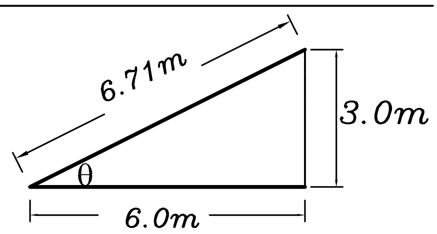
$f_{cu}=25\ N/mm^2$, $f_y=360\ N/mm^2$

Columns are only allowed on perimeter

Solution

$$t = \frac{671}{16} = 41.94cm$$

take $t=25\ cm$ [20cm+5cm]



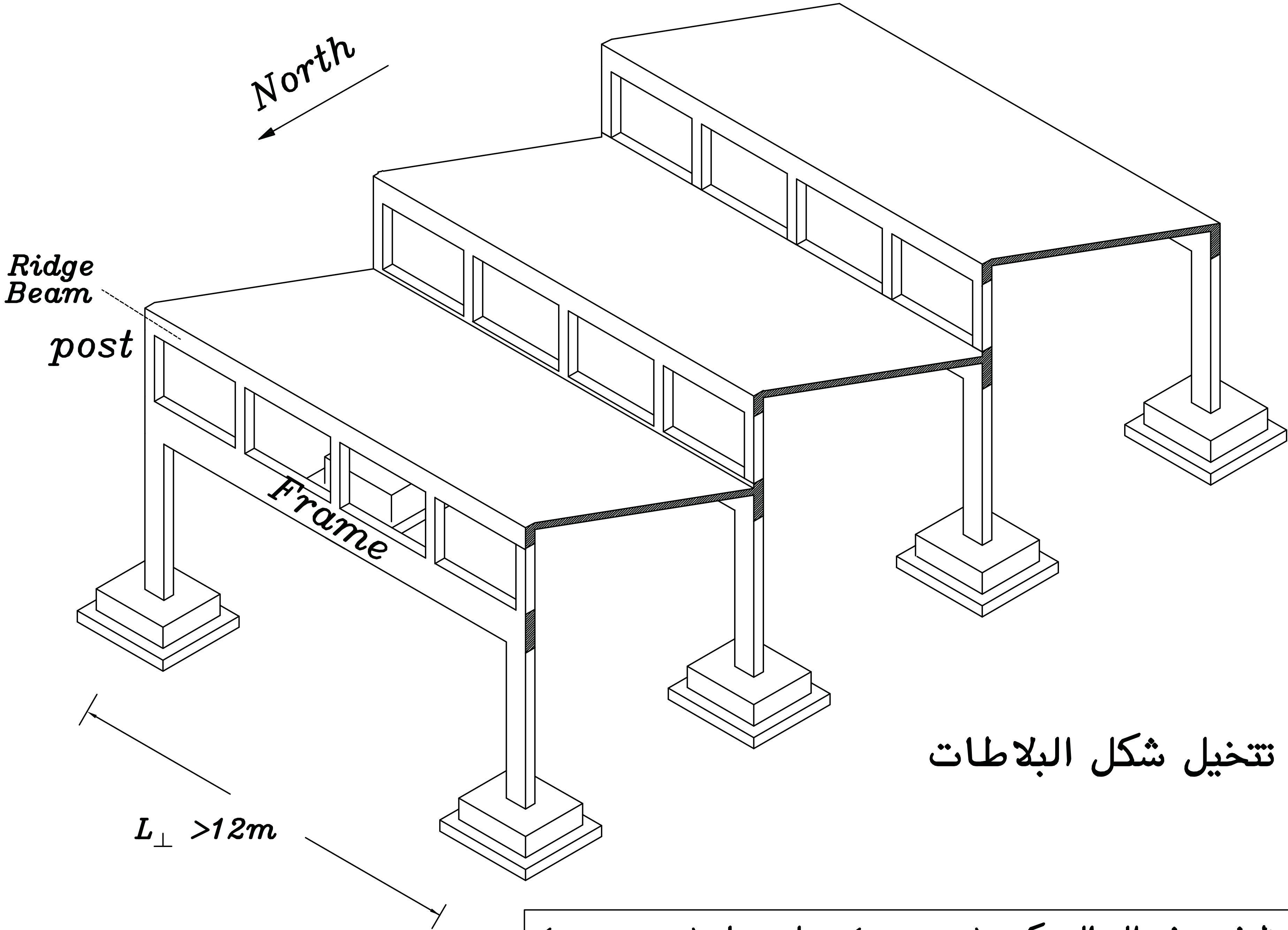
$$\theta = \tan^{-1}\left(\frac{3}{6.0}\right) = 26.57$$

$$w_{su} = 1.4(t_s \gamma_c + F.C. + 2bh\gamma_c + 10*wt.of\ block] + 1.6 L.L. Cos\theta$$

$$w_{su} = 1.4(0.05*25 + 1.5 + 2*0.1*0.2*25 + 10*0.15] + 1.6*0.5*0.89$$

$$w_{su} = 8.06 kN/m^2$$

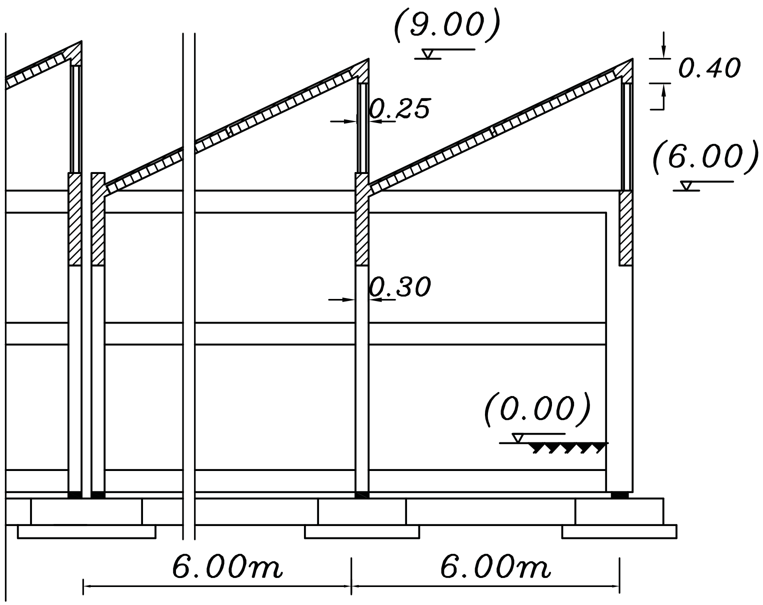
$$w_{su/Rib} = 0.5*8.06 = 4.03 kN/m'$$



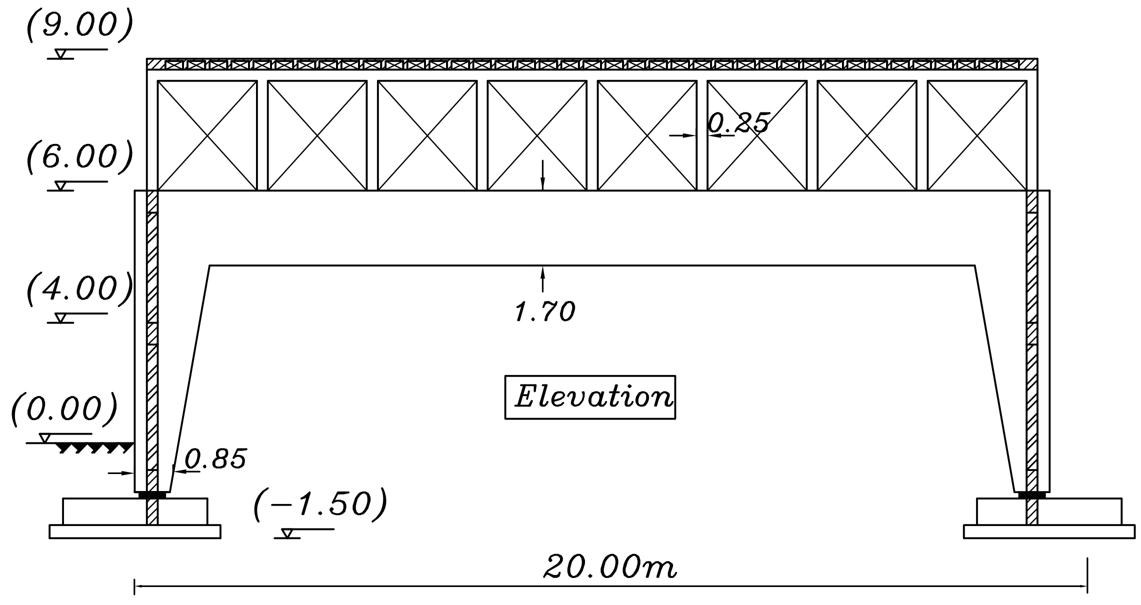
حاول تتخيل شكل البلاطات

لاحظ فى هذه الحالة يكون (Frame) يحل محل (Y-beam)

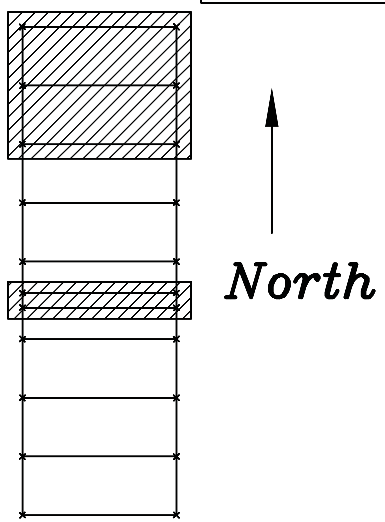
By Eng. Ezz El-Din Mostafa & Eng. Yasser M. Samir



Side view

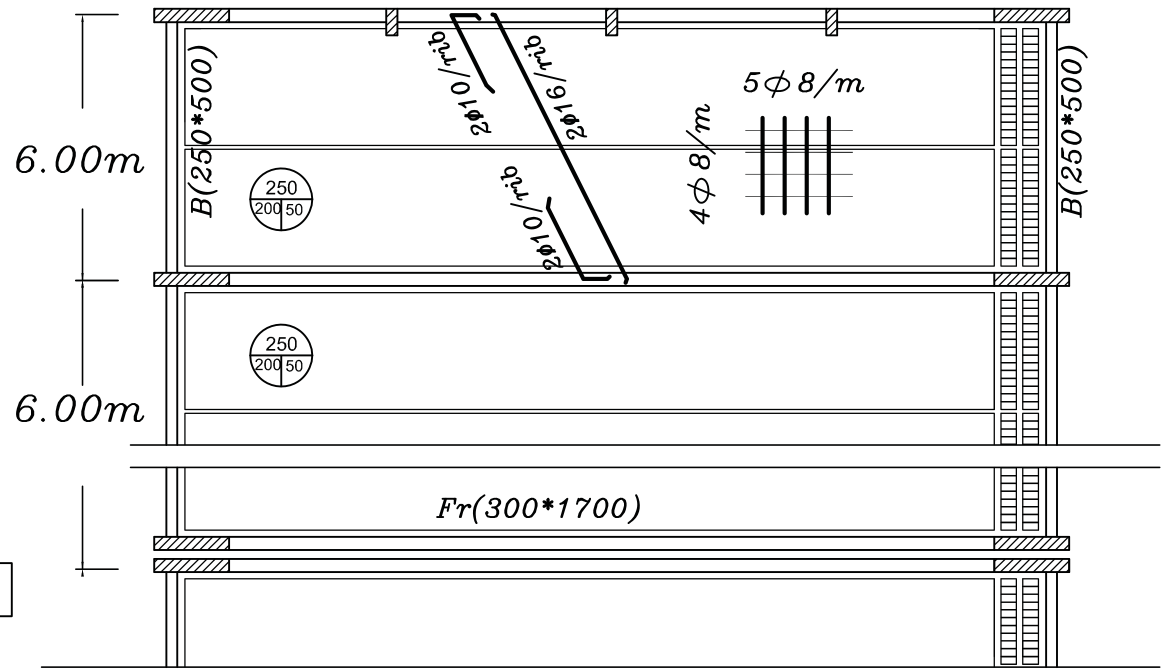


Elevation



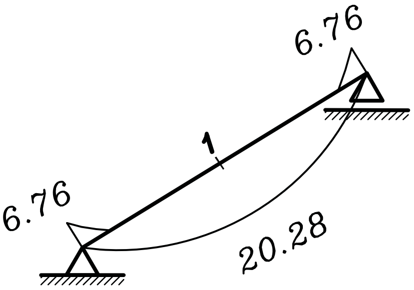
KEY PLAN

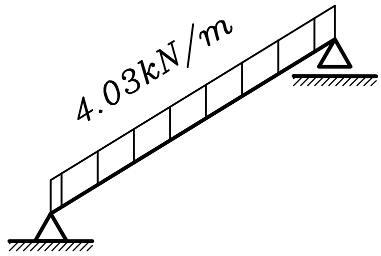
1:200⟶1:400



Plan

B.M.D.





Sec. (1−1)

$$220 = C_1\sqrt{\frac{20.28*10^6}{500*25}} \qquad C_1 = 5.46 \qquad J = 0.826$$

$$A_s = \frac{20.28*10^6}{0.826*360*220} = 3.10 cm^2/rib$$

$A_s = 2\Phi 16/rib$

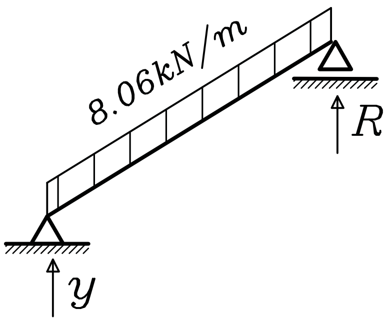
Sec. (2−2)

$A_s = 2\Phi 10/rib$

2]Reactions of slabs on beams

$R = y = w_{su}\,\frac{L'}{2} \qquad kN/m$

$R = y = 8.06*6.71/2 = 27.04 \quad kN/m$



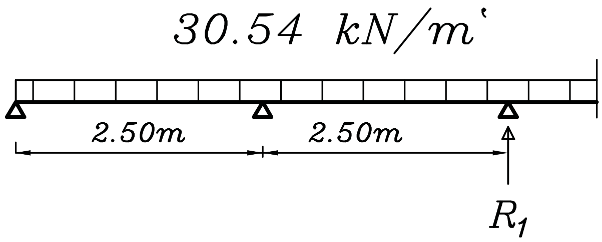
3]Analysis of Ridge beam(250*400)

$w = R + o.w \qquad kN/m$

$w = 27.04 + 0.25*0.40*25*1.40$

$w = 30.54 \quad kN/m$

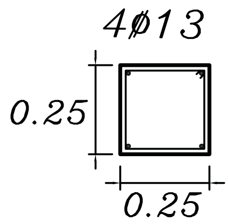
$R_1 = 30.54*2.5 = 76.35 kN$



4]Design of Posts

$R_p = R_1 + o.w \;\; of \;\; Post$

$R_p = 76.35 + 0.25*0.25*3*25*1.40 = 82.91 kN$



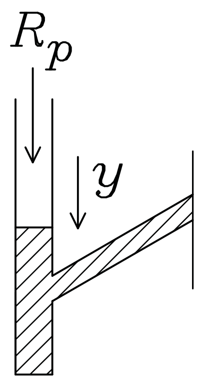
$82.91*10^3 = 0.35*250*250*25 + 0.67 A_s f_y$

$A_s = -ve \longrightarrow A_s = 4ф13$

5]Design of main system

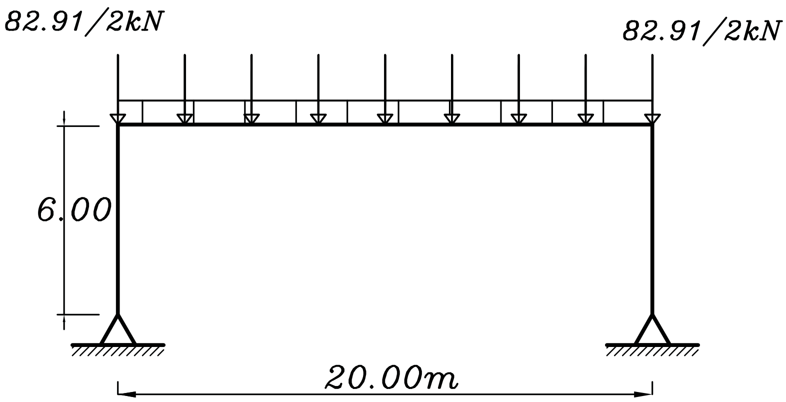
لاحظ فى هذه الحالة يكون (Frame) هو نفسه (Y-beam)

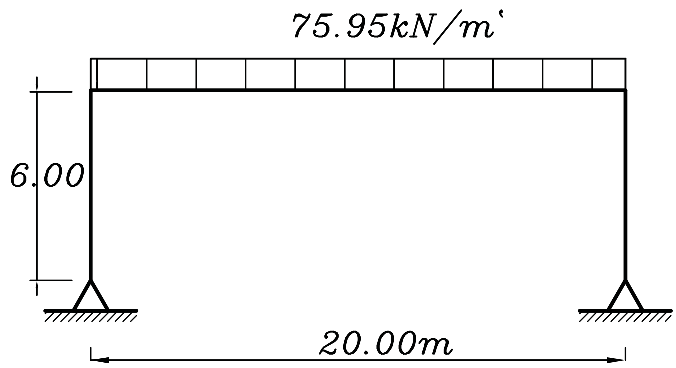
$$w_f = o.w. + y + \frac{\Sigma R_p}{Span} \quad kN/m$$

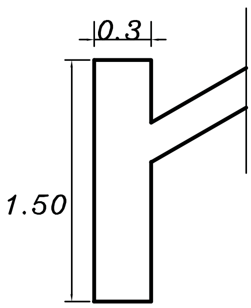


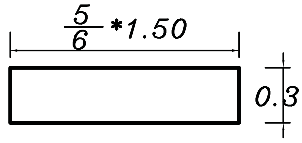
$$w_f = 0.30*1.50*25*1.40 + 27.04 + \frac{8*82.91}{20.0}$$

$$w_f = 75.95 kN/m$$









$$I_c = \frac{0.30*(\frac{5}{6}*1.50)^3}{12}$$

$$I_c = 0.049 m^4$$

$$I_b = 0.3*\frac{1.5^3}{12} = 0.084 m^4$$

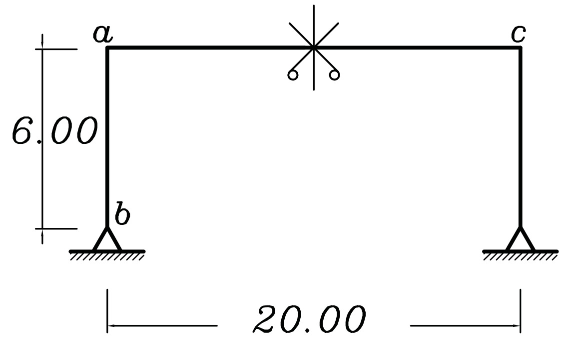
For Joint a

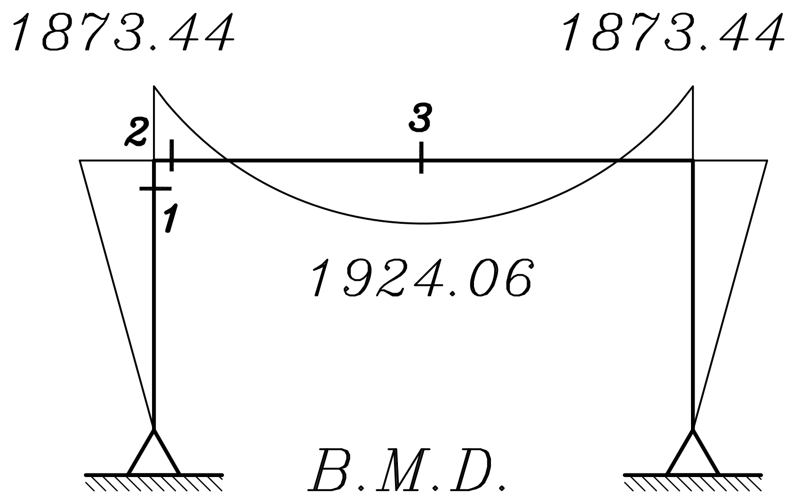
$$D.f_{ab} = \frac{0.75(I_c/h)}{(0.75\frac{I_c}{h})+(0.5\frac{I_b}{L})}$$

$$D.f_{ab} = \frac{0.75*(0.049/6.00)}{0.75*(0.049/6.00)+0.50*(0.084/20)}$$

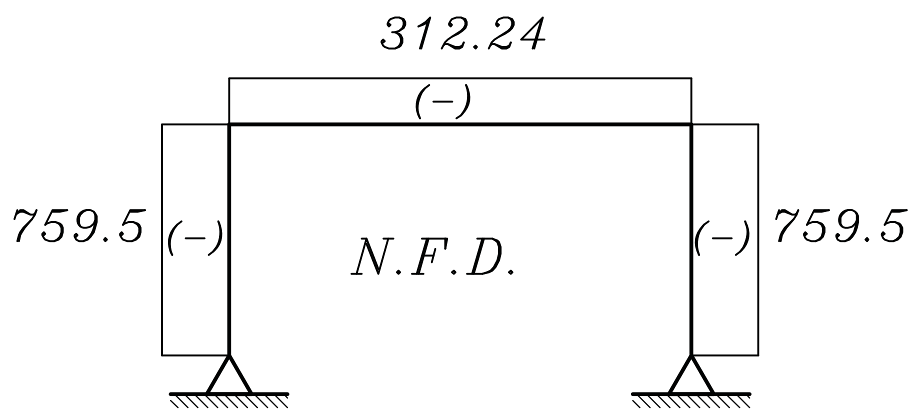
$D.f_{ab}=0.74$ $\quad D.f_{ac}=1-0.74=0.26$

$F.E.M.=75.95*20^2/12=2532\ kN$

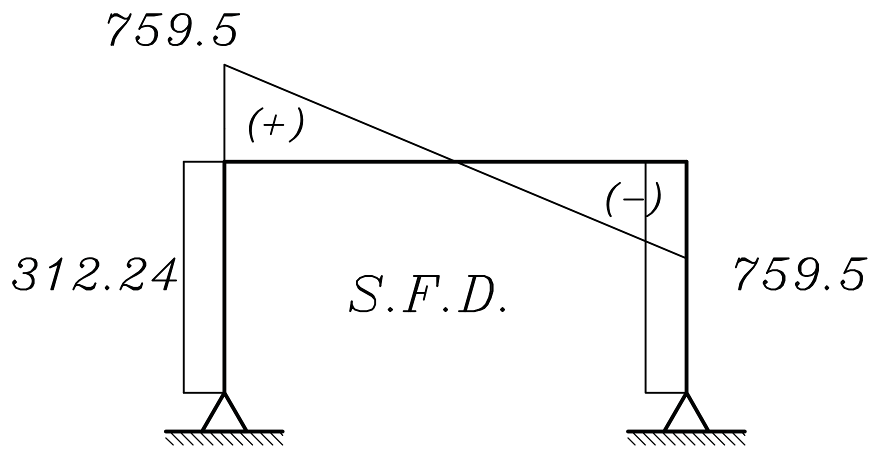




B.M.D.



N.F.D.

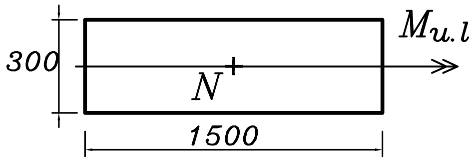


S.F.D.

Design of Sections

Sec. (1-1) $\quad M_{u.l.}=1873.44kN.m \qquad N_{u.l.}=759.50kN.m$

$b=300mm \;, \qquad t=1500mm$



$$\frac{N_{u.l.}}{btf_{cu}}=\frac{759.50*10^{3}}{300*1500*25}=0.068>0.04 \text{ (Dont neglect } N_{u.l.}\text{)}$$

$$e=\frac{M_{u.l.}}{N_{u.l.}}=\frac{1873.44}{759.50}=2.47m$$

$$\frac{e}{t}=\frac{2.47}{1.50}=1.64 > 0.5 \text{ (big eccentricity)}$$

$$e_s=e+\frac{t}{2}-c=2.47+\frac{1.50}{2}-0.1=3.12m$$

$$M_{us}=759.50*3.12=2367.12kN.m$$

$$d=C_1\sqrt{\frac{M_{us}}{b*f_{cu}}}$$

$$1400=C_1\sqrt{\frac{2367.12*10^6}{300*25}} \qquad C_1=2.49<2.78 \quad \text{take } d=1600mm$$

$$e_s=e+\frac{t}{2}-c=2.47+\frac{1.70}{2}-0.1=3.22m$$

$$M_{us}=759.50*3.22=2445.59kN.m$$

$$1600=C_1\sqrt{\frac{2445.59*10^6}{300*25}} \qquad C_1=2.80 \;\&\; J=0.72$$

$$A_s=\frac{M_{us}}{J.d.f_y}-\frac{N_{us}}{f_y/\gamma_s}$$

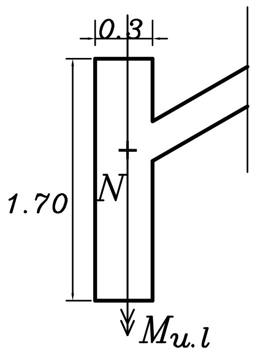
$$A_s=\frac{2445.59*10^6}{0.72*1600*360}-\frac{759.50*10^3}{360/1.15}$$

$$A_s=34.75cm^2=10\phi 22$$

Sec. (2-2) $M_{u.l.} = 1873.44 kN.m$ $N_{u.l.} = 312.24 kN.m$

$b = 300mm$, $t = 1700mm$

$$\frac{N_{u.l.}}{btf_{cu}} = \frac{312.24*10^3}{300*1700*25} = 0.024 < 0.04 \quad (\text{ neglect } N_{u.l.})$$



$$d = C_1 \sqrt{\frac{Mu.l.}{b*f_{cu}}}$$

$$1600 = C_1 \sqrt{\frac{1873.44*10^6}{300*25}} \qquad C_1 = 3.20 \;\; \& \;\; J = 0.76$$

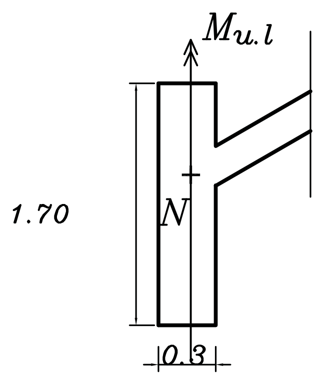
$$A_s = \frac{1873.44*10^6}{0.76*1600*360}$$

$$A_s = 42.75 cm^2 = 12\phi22$$

Sec. (3-3) $M_{u.l.} = 1924.06 kN.m$ $N_{u.l.} = 312.24 kN.m$

$b = 300mm$, $t = 1700mm$

$$\frac{N_{u.l.}}{btf_{cu}} = \frac{312.24*10^3}{300*1700*25} = 0.024 < 0.04 \quad (\text{ neglect } N_{u.l.})$$



$$d = C_1 \sqrt{\frac{Mu.l.}{b*f_{cu}}}$$

$$1600 = C_1 \sqrt{\frac{1924.06*10^6}{300*25}} \qquad C_1 = 3.16 \;\; \& \;\; J = 0.76$$

$$A_s = \frac{1924.06*10^6}{0.76*1600*360}$$

$$A_s = 44.11 cm^2 = 12\phi22$$

Check Shear

$$Q_{cr}=Q_{max}-w\left(\frac{c}{2}+\frac{d}{2}\right)$$

$$Q_{cr}=759.5-75.95\left(\frac{1.70}{2}+\frac{1.60}{2}\right)$$

$$Q_{cr}=634.18kN$$

$$q_{su}=\frac{Q_{cr}}{bd}=\frac{634.18*10^3}{300*1600}=1.32\ N/mm^2$$

$$q_{cu}=0.24\sqrt{\frac{25}{1.5}}=0.98\ N/mm^2$$

$$q_{max}=0.7\sqrt{\frac{25}{1.5}}=2.86\ N/mm^2$$

$$\boldsymbol{q_{cu}<q_u<q_{umax}}$$

$$q_u-\frac{q_{cu}}{2}=\frac{nA_s f_y/\gamma_s}{bS}$$

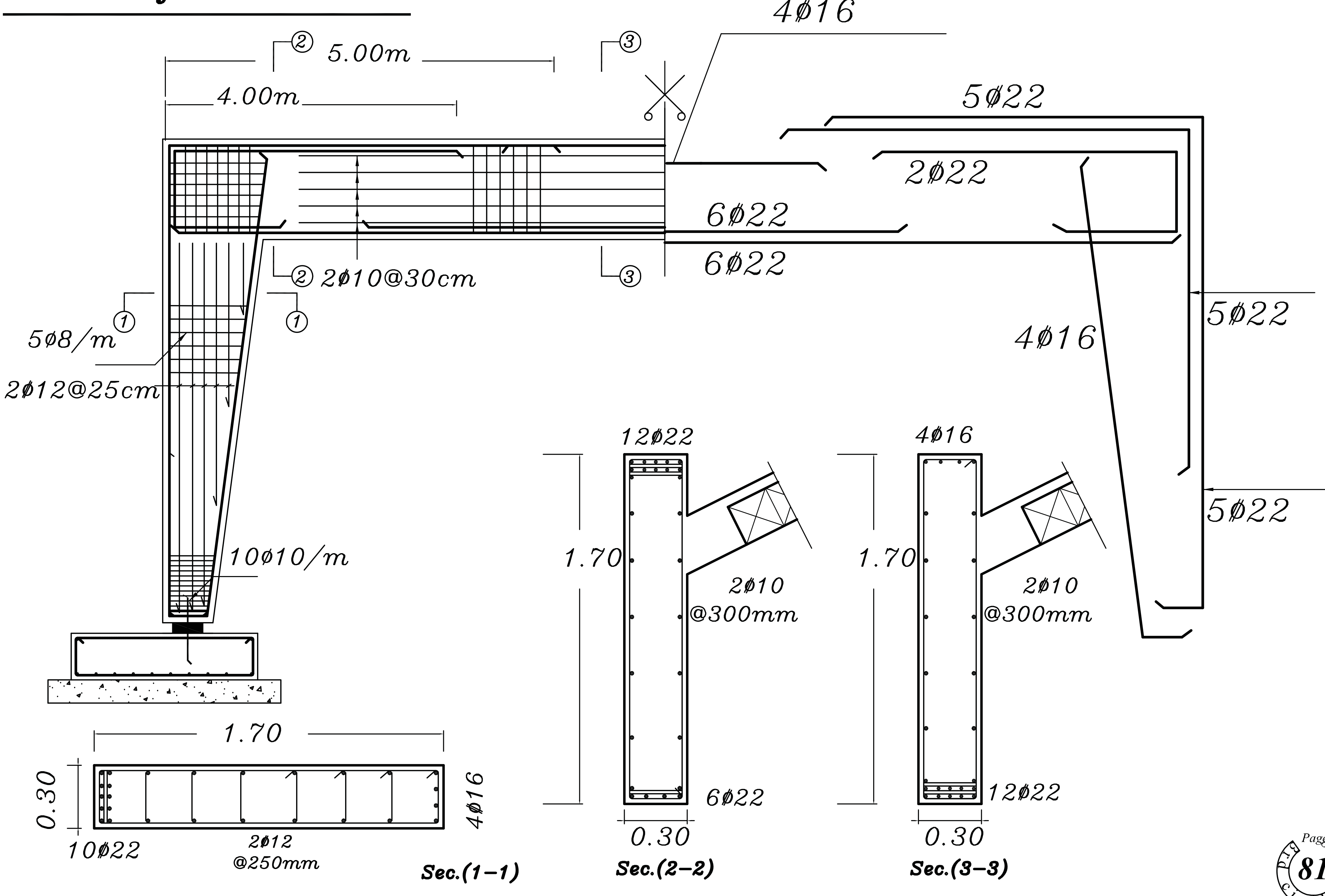
assume $n=2$ $\quad A_s=78.5mm^2=\phi 10$

$$1.32-\frac{0.98}{2}=\frac{2*78.5*240/1.15}{300*S} \longrightarrow S=131.59mm$$

$$No.of\ stirrups/m'=\frac{1000}{S}=7.6$$

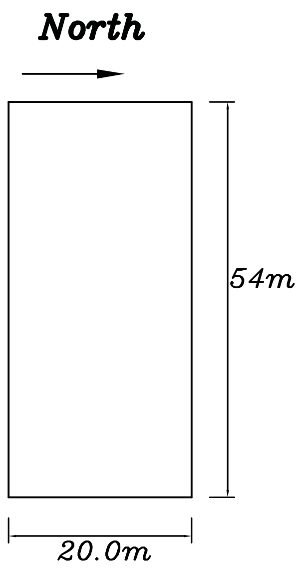
Take Stirrups $8\phi 10/m'$

R.F.T. of the Frame



Example

For the given plan, it is required to:



1-Choose the suitable system to cover this Area.

2-Design all Slabs and draw plan of Rft.

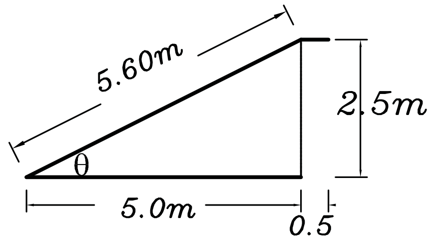
3-Design the main supporting element and draw details of Rft.

$F.C.=1.5 kN/m^2$,$L.L=0.5\ kN/m^2$

$f_{cu}=25\ N/mm^2$, $f_y=360\ N/mm^2$

Columns are only allowed on perimeter

Solution



$\theta=\tan^{-1}(\frac{2.5}{5.0})=26.57$

$$t_s=\frac{560}{24}=23.33cm$$

$$t_{s_{min}}=\frac{560}{35}=16.00cm$$

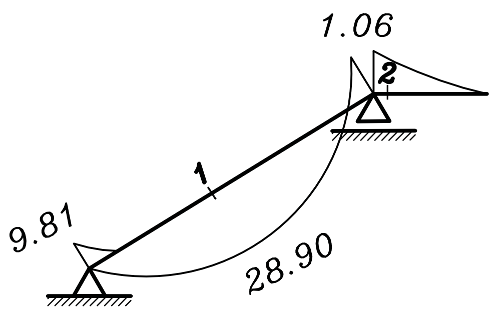
take $t_S=16\ cm$ (Check def.)

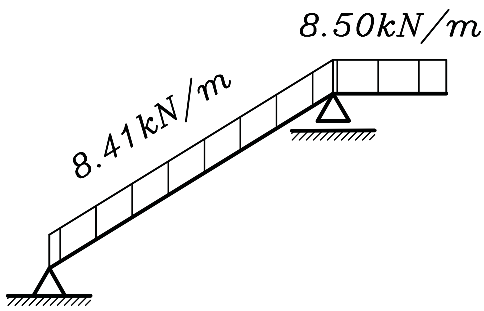
$$w_{su}=1.4[t_s\gamma_c+F.c.]+1.6\ L.L.Cos\theta$$

$$w_{su}=1.4[0.16*25+1.5]+1.6*0.5*0.89$$

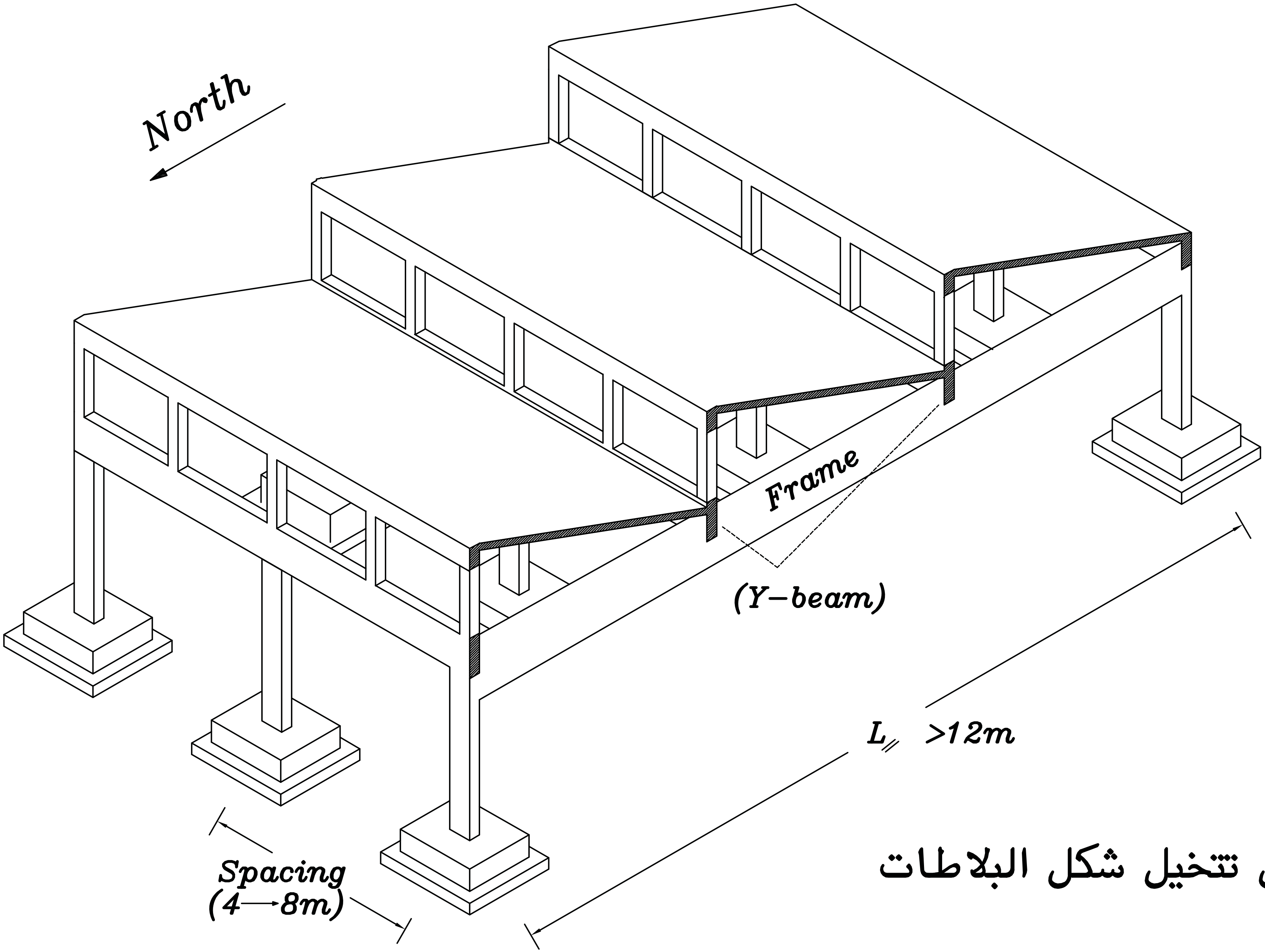
$$w_{su}=8.41 kN/m^2$$

B.M.D.

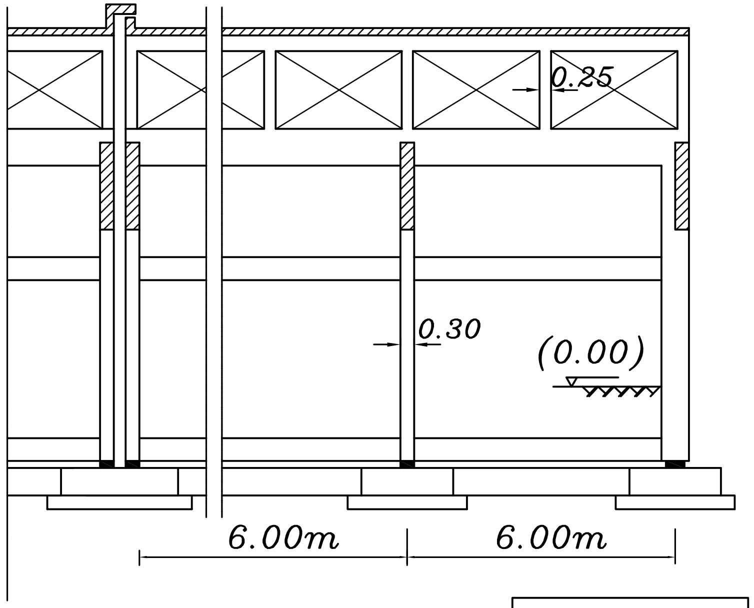




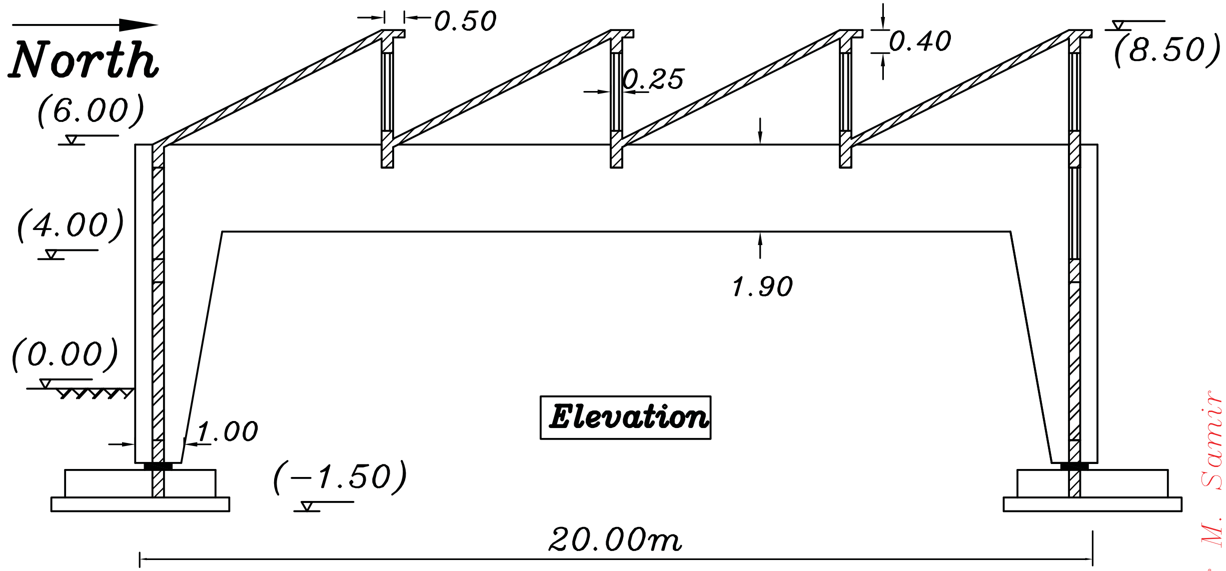
حاول تتخيل شكل البلاطات

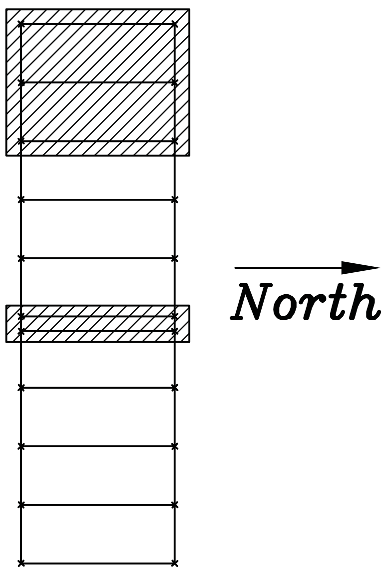


لاحظ فى هذه الحالة يكون (Y−beam) هى ال(Sec.−beam)



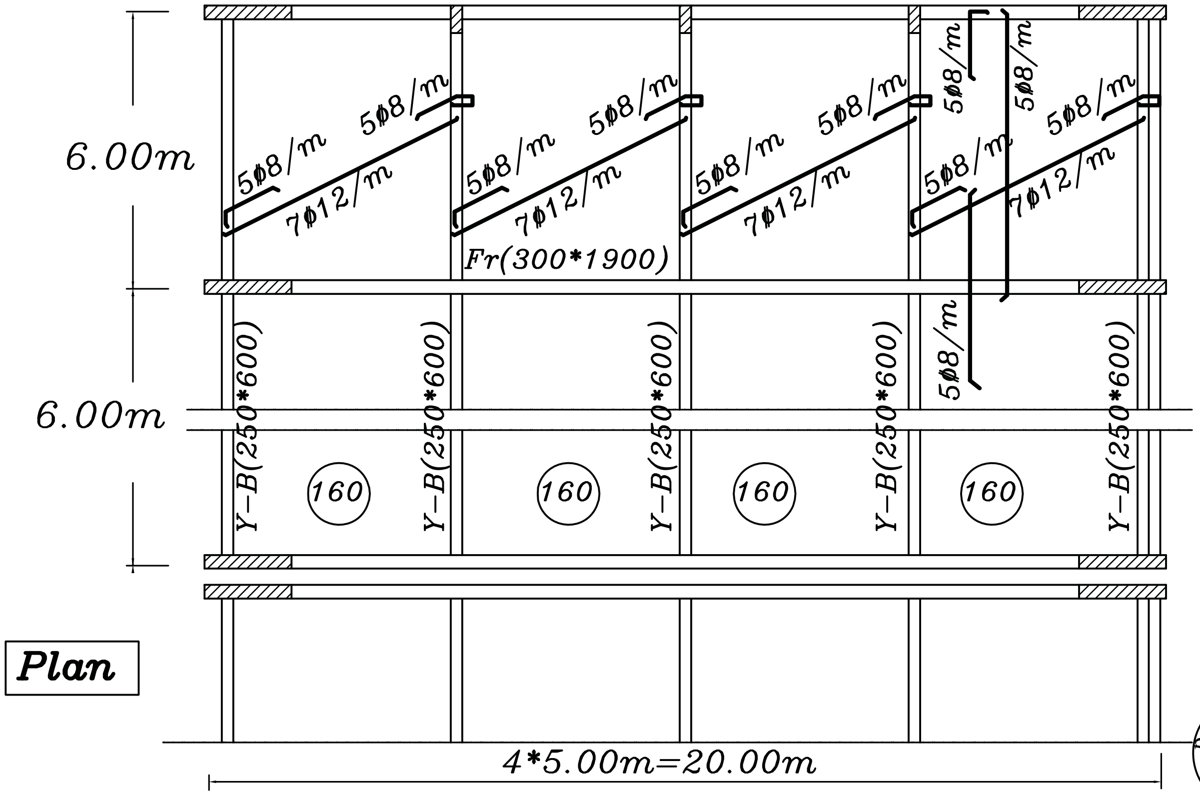
Side view





KEY PLAN

1:200 ⟶ 1:400



Plan

Sec. (1-1)

$$140 = C_1 \sqrt{\frac{28.90*10^6}{1000*25}} \qquad C_1 = 4.12 \qquad J = 0.807$$

$$A_s = \frac{28.90*10^6}{0.807*360*140} = 710 mm^2/m'$$

$$A_s = 7\Phi 12/m'$$

Sec. (2-2)

$$A_s = 5\Phi 8/m'$$

2]Reactions of slabs on beams

$$\Sigma M_a = 0$$

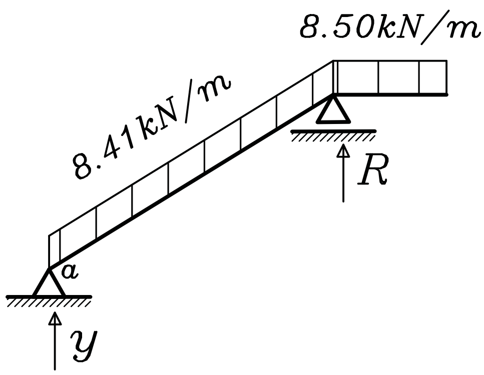
$$8.41*5.60*5.0/2+8.50*0.5*5.25=R*5.00$$

$$R=28.01 kN/m$$

$$\Sigma y = o$$

$$8.41*5.60+8.50*0.5=R+y$$

$$y=23.34 kN/m$$



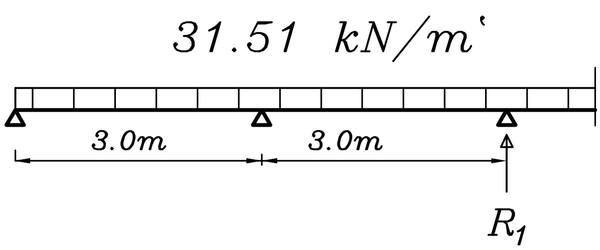
3]Analysis of Ridge beam(250*400)

$$w=R+o.w \qquad kN/m$$

$$w=28.01+0.25*0.40*25*1.40$$

$$w=31.51 \quad kN/m$$

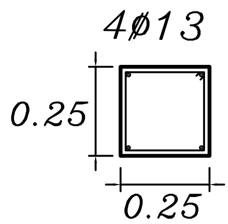
$$R_1 = 31.51*3.0 = 94.53 kN$$



4]Design of Posts

$$R_p = R_1 + o.w \text{ of Post}$$

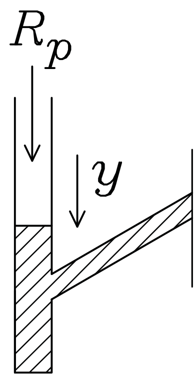
$R_p = 94.53 + 0.25*0.25*2.5.*25*1.40 = 100.00kN$



$100.00*10^3 = 0.35*250*250*25 + 0.67 A_s f_y$

$A_s = -ve \longrightarrow A_s = 4\phi13$

5]Design of of Y-beam

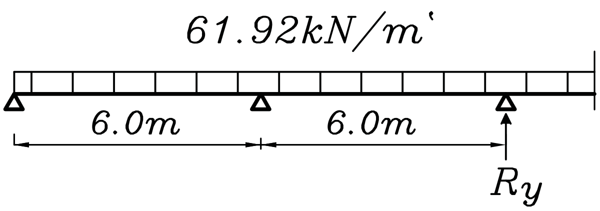


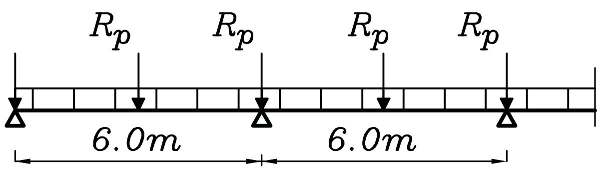
$$w_y = o.w. + y + \frac{\Sigma R_p}{Span} \quad kN/m$$

$$w_y = 0.25*0.60*25*1.40 + 23.34 + \frac{2*100.0}{6.0}$$

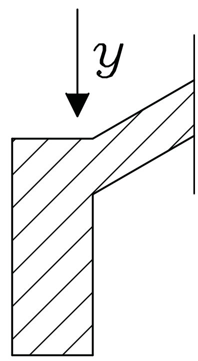
$$w_y = 61.92kN/m$$

$$R_y = 61.92*6.0 = 371.54 \quad kN$$





6]Analysis of End beam

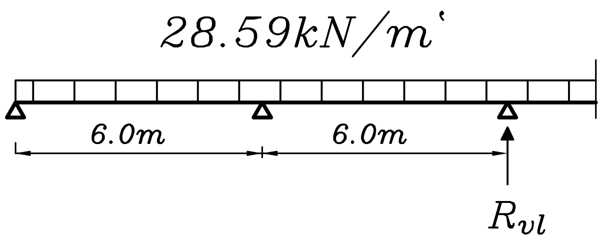


$$w_{vl.} = o.w + y \qquad kN/m$$

$$w_{vl.} = 0.25*0.60*25*1.40 + 23.34$$

$$w_{vl.} = 28.59kN/m$$

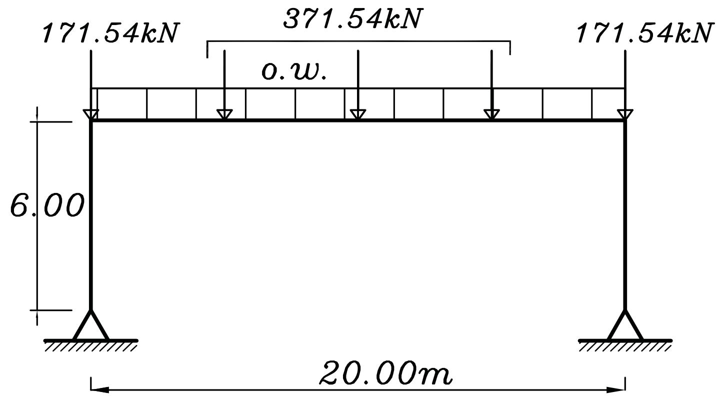
$$R_{vl.} = 28.59*6.0 = 171.54kN$$

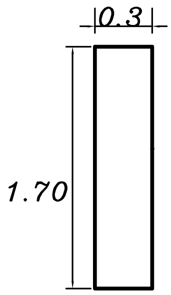


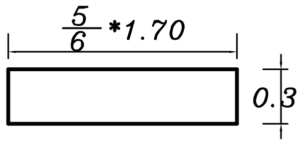
7]Design of Main system

o.w.=0.30*1.70*25*1.40

o.w.=17.85kN/m







$$I_b = 0.3*\frac{1.7^3}{12}=0.123m^4$$

$$I_c = \frac{0.30*(\frac{5}{6}*1.70)^3}{12}$$

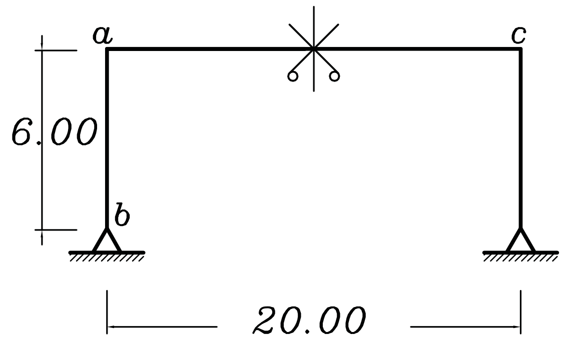
$$I_c = 0.071m^4$$

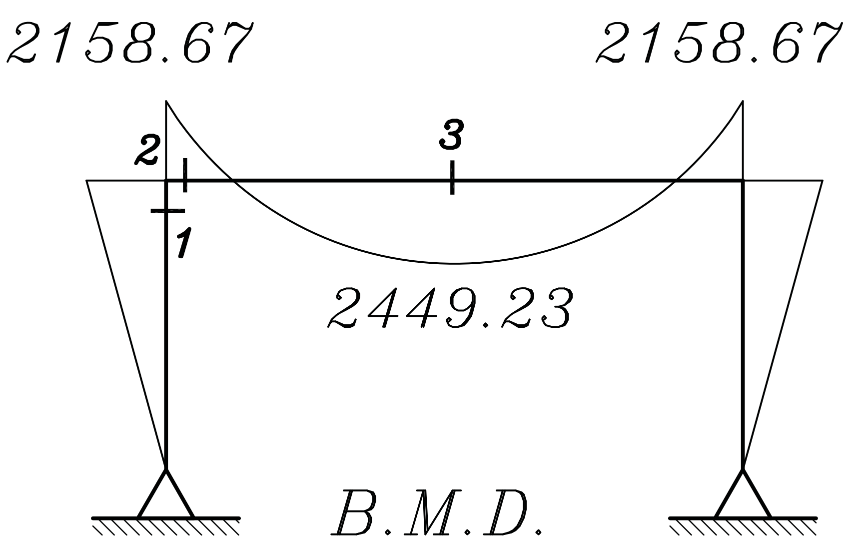
For Joint a

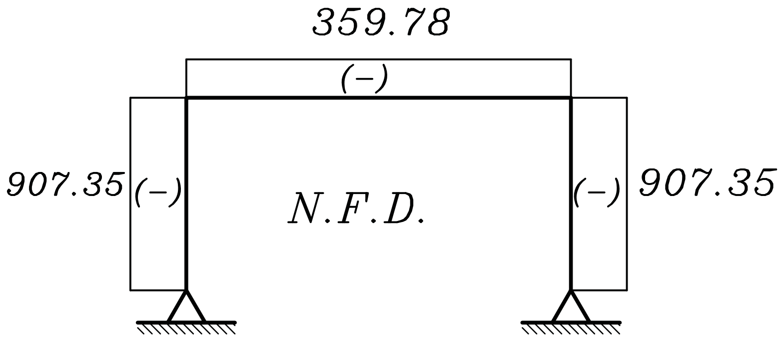
$$D.f_{ab} = \frac{0.75(I_c/h)}{(0.75\frac{I_c}{h})+(0.5\frac{I_b}{L})}$$

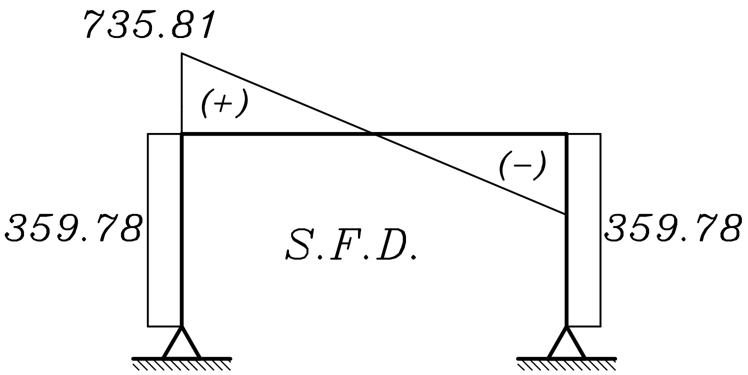
$$D.f_{ab} = \frac{0.75*(0.071/6.00)}{0.75*(0.071/6.00)+0.50*(0.123/20)}$$

$$D.f_{ab} = 0.72$$





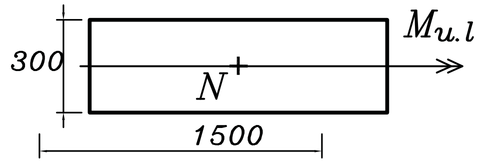




Design of Sections

Sec. (1−1) $\quad M_{u.l.} = 2158.67 kN.m \qquad N_{u.l.} = 907.35 kN.m$

b=300mm , t=1700mm



$$\frac{N_{u.l.}}{btf_{cu}} = \frac{907.35*10^3}{300*1700*25} = 0.071 > 0.04 \quad (Dont\ neglect\ N_{u.l.})$$

$$e = \frac{M_{u.l.}}{N_{u.l.}} = \frac{2158.67}{907.35} = 2.37m$$

$$\frac{e}{t} = \frac{2.37}{1.70} = 1.39 > 0.5 \quad (big\ eccentricity)$$

$$e_s = e + \frac{t}{2} - c = 2.37 + \frac{1.70}{2} - 0.1 = 3.12m$$

$$M_{us} = 907.35*3.12 = 2832.07 kN.m$$

$$d = C_1 \sqrt{\frac{M_{us}}{b*f_{cu}}}$$

$$1600 = C_1 \sqrt{\frac{2832.07*10^6}{300*25}} \qquad C_1 = 2.60 < 2.78 \quad take\ d = 1800mm$$

$$e_s = e + \frac{t}{2} - c = 2.47 + \frac{1.90}{2} - 0.1 = 3.32m$$

$$M_{us} = 907.35 * 3.32 = 3012.40kN.m$$

$$1800 = C_1 \sqrt{\frac{3012.40*10^6}{300*25}} \qquad C_1 = 2.84 \quad \& \quad J = 0.72$$

$$A_s = \frac{M_{us}}{J.d.f_y} - \frac{N_{us}}{f_y/\gamma_s}$$

$$A_s = \frac{30124.40*10^6}{0.72*1800*360} - \frac{907.35*10^3}{360/1.15}$$

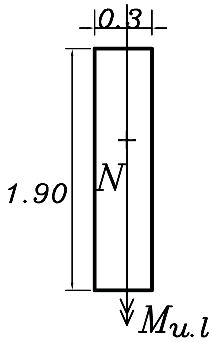
$$A_s = 35.18cm^2 = 10\phi22$$

<u>Sec. (2-2)</u> $\quad \boldsymbol{M_{u.l.} = 2158.67kN.m} \qquad \boldsymbol{N_{u.l.} = 359.78kN.m}$

b=300mm , t=1900mm

$$\frac{N_{u.l.}}{btf_{cu}} = \frac{359.78*10^3}{300*1900*25} = 0.025 < 0.04 \quad (\text{ neglect } N_{u.l.})$$

$$d = C_1 \sqrt{\frac{M_{u.l.}}{b*f_{cu}}}$$



$$1800 = C_1 \sqrt{\frac{2158.67*10^6}{300*25}} \qquad C_1 = 3.36 \quad \& \quad J = 0.77$$

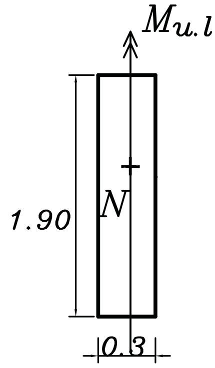
$$A_s = \frac{2158.67*10^6}{0.77*1800*360}$$

$$A_s = 43.16cm^2 = 12\phi22$$

<u>Sec. (3-3)</u> $\quad \boldsymbol{M_{u.l.} = 2449.23kN.m} \qquad \boldsymbol{N_{u.l.} = 359.78kN.m}$

b=300mm , t=1900mm

$$d = C_1 \sqrt{\frac{M_{u.l.}}{b * f_{cu}}}$$



$$1800 = C_1 \sqrt{\frac{2449.23 * 10^6}{300 * 25}} \qquad C_1 = 3.15 \quad \& \quad J = 0.76$$

$$A_s = \frac{2449.23 * 10^6}{0.76 * 1800 * 360}$$

$$A_s = 49.96 cm^2 = 11 \phi 25$$

Check Shear

$$Q_{cr} = Q_{max} - w\left(\frac{c}{2} + \frac{d}{2}\right)$$

$$Q_{cr} = 735.81 - 17.85\left(\frac{1.90}{2} + \frac{1.80}{2}\right)$$

$$Q_{cr} = 702.79 kN$$

$$q_{su} = \frac{Q_{cr}}{bd} = \frac{702.79 * 10^3}{300 * 1800} = 1.31 \ N/mm^2$$

$$q_{cu} = 0.24 \sqrt{\frac{25}{1.5}} = 0.98 \ N/mm^2$$

$$\mathbf{q_{cu} < q_u < q_{umax}}$$

$$q_{max} = 0.7 \sqrt{\frac{25}{1.5}} = 2.86 \ N/mm^2$$

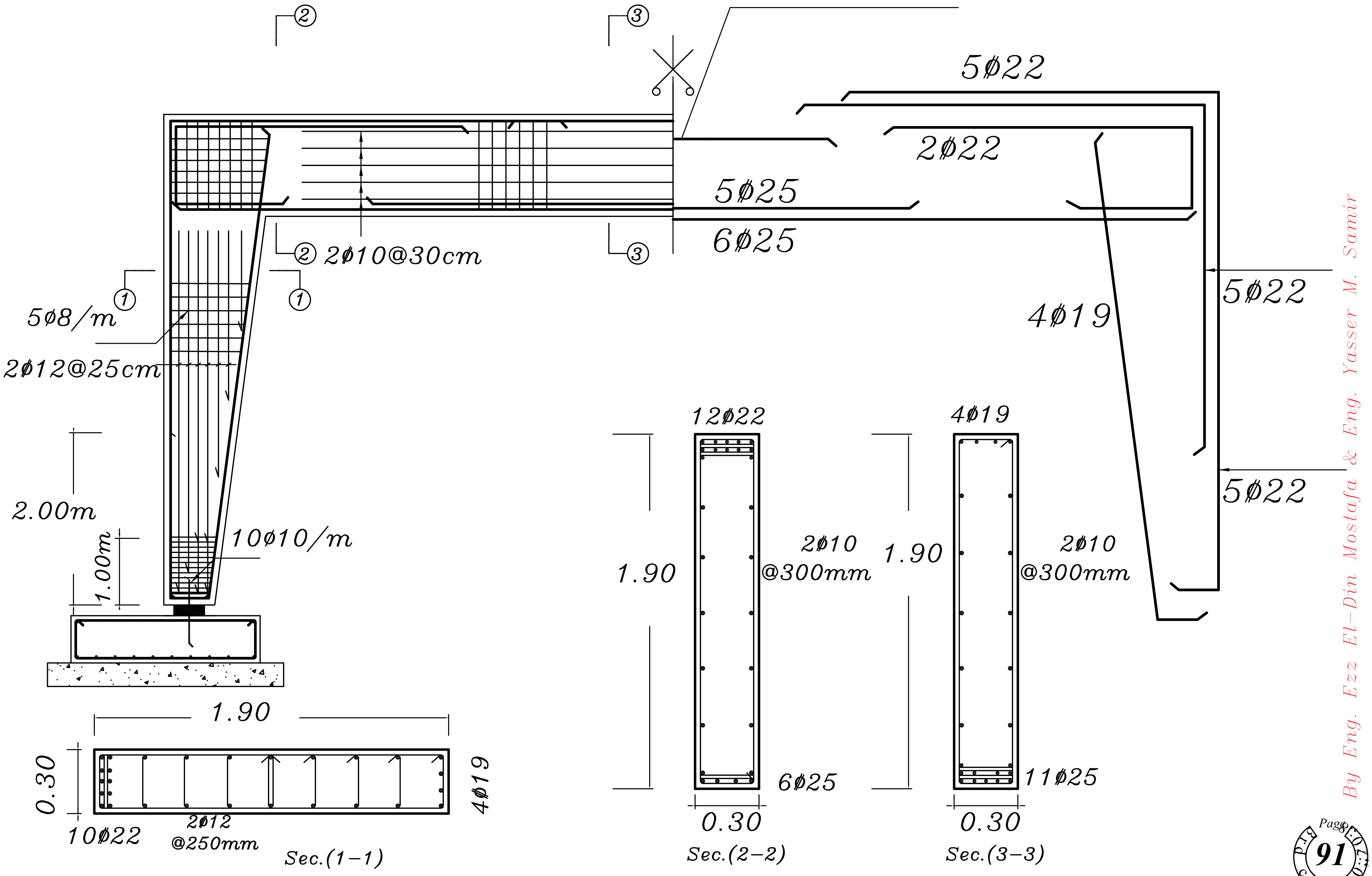
$$q_u - \frac{q_{cu}}{2} = \frac{n A_s f_y / \gamma_s}{bS}$$

assume $n = 2$ $\qquad A_s = 78.5 mm^2 = \phi 10$

$$1.31 - \frac{0.98}{2} = \frac{2 * 78.5 * 240 / 1.15}{300 * S} \longrightarrow S = 133.19 mm$$

$$No.of\ stirrups/m' = \frac{1000}{S} = 7.5$$ **Take Stirrups $8\phi 10/m'$**

R.F.T. of the Frame



By Eng. Ezz El-Din Mostafa & Eng. Yasser M. Samir

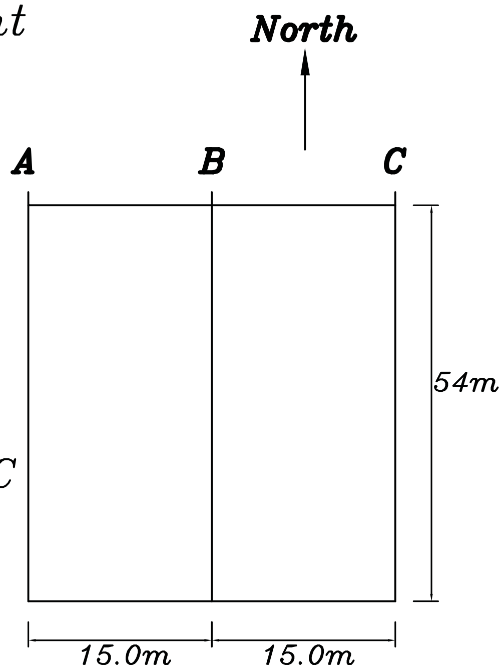
Example

For the given plan, it is required to:

1−Choose the suitable system to cover this Area.

2−Design all Slabs and draw plan of Rft.

3−Design the main supporting element and draw details of Rft.



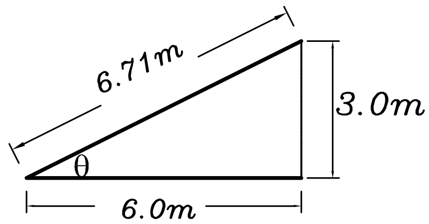
$F.C.=1.5kN/m^2$,$L.L=0.5\ kN/m^2$

$f_{cu}=32.5\ N/mm^2$,$f_y=360\ N/mm^2$

Columns are only allowed on axes A,B,C

Solution

Use continuous frame



$$t = \frac{671}{16} = 41.94cm$$

take t=25 cm [20cm+5cm]

$$\theta = tan^{-1}(\frac{3}{6.0}) = 26.57$$

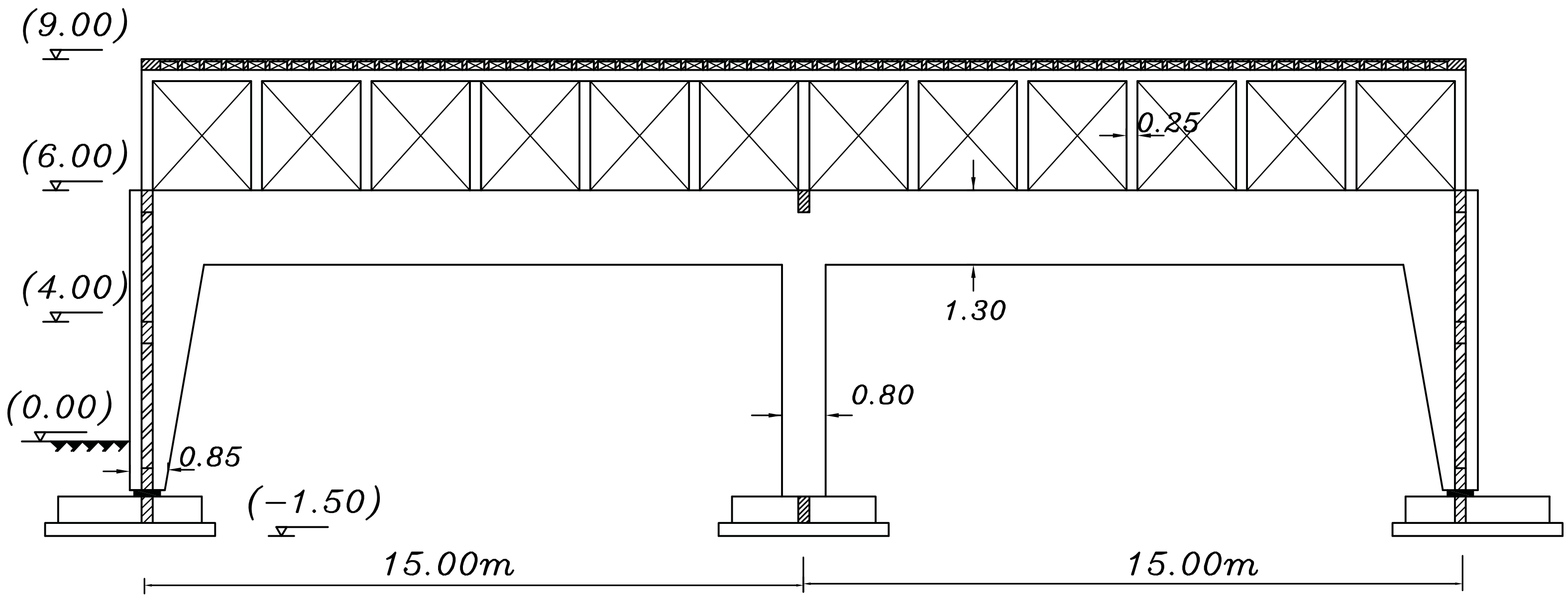
$$w_{su}=1.4(t_s\gamma_c+F.C.+2bh\gamma_c+10*wt.of\ block]+1.6L.L.Cos\theta$$

$$w_{su}=1.4(0.05*25+1.5+2*0.1*0.2*25+10*0.15]+1.6*0.5*0.89$$

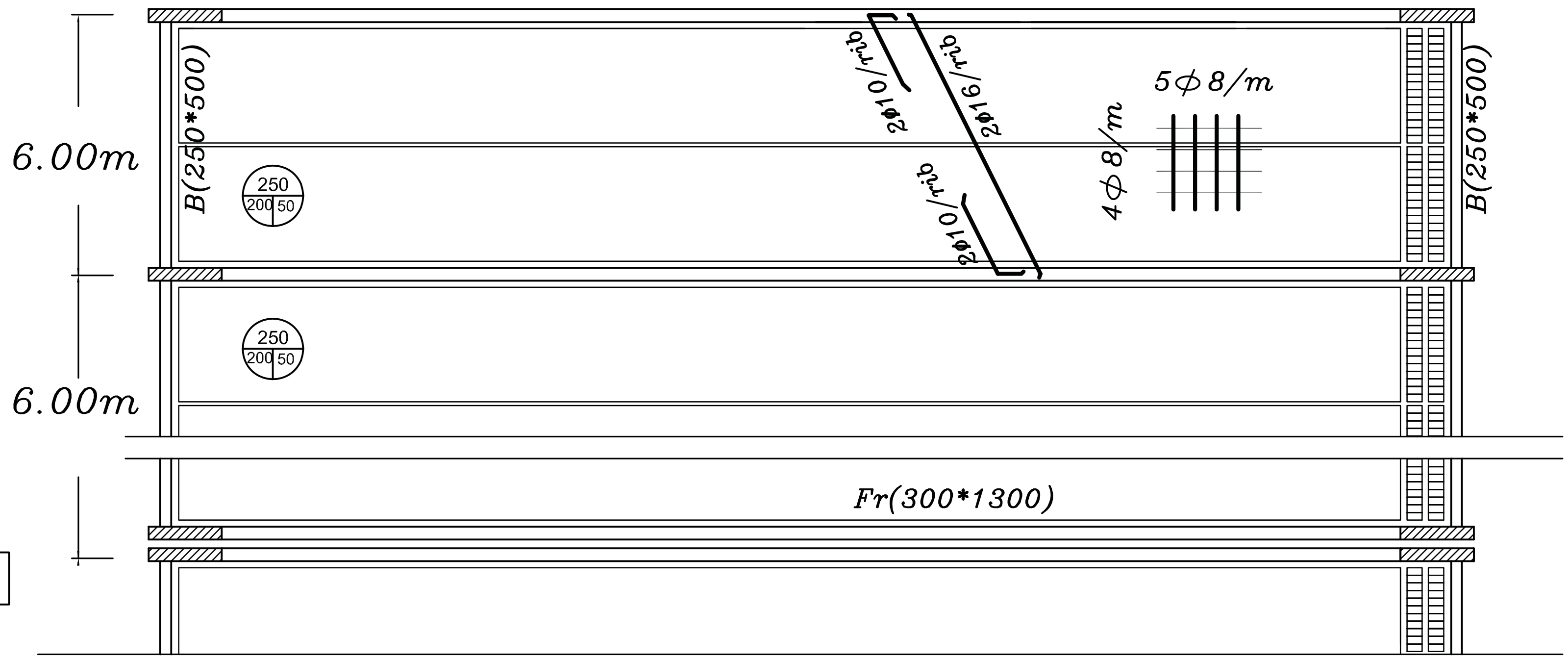
$$w_{su}=8.06kN/m^2$$

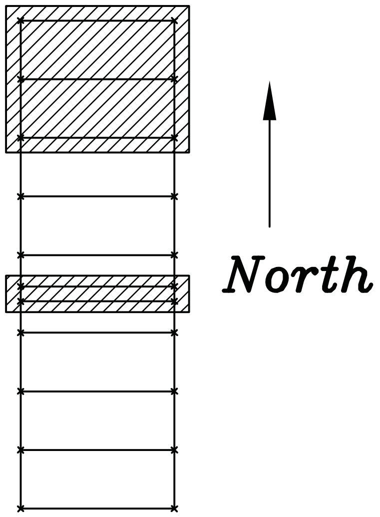
$$w_{su/Rib}=0.5*8.06=4.03kN/m'$$

Elevation

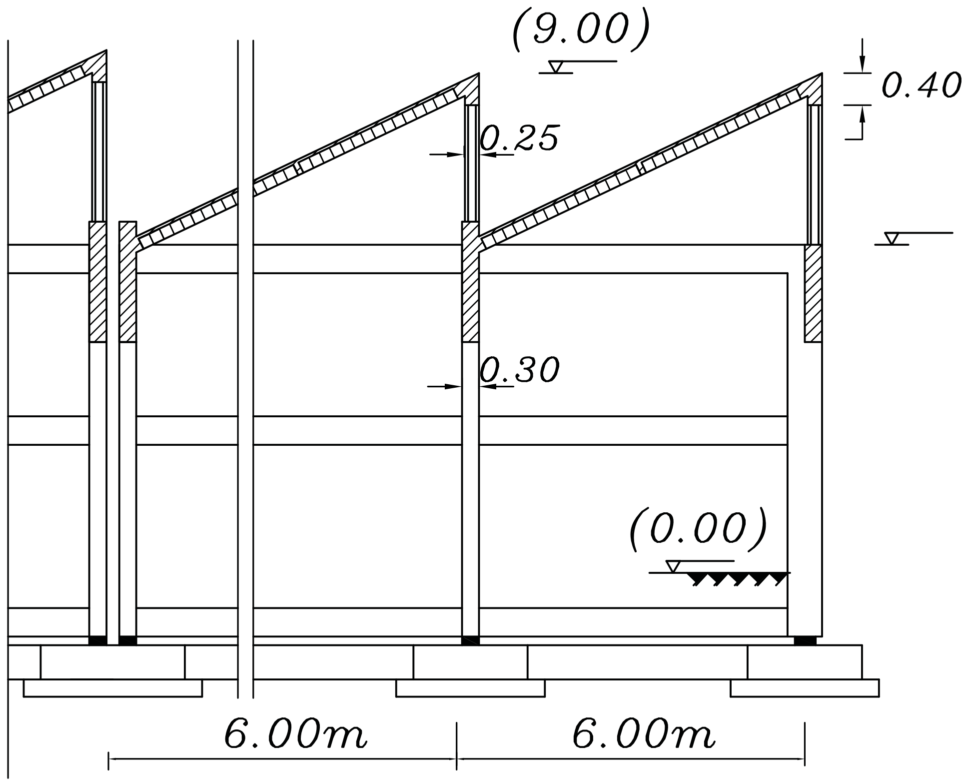


Plan



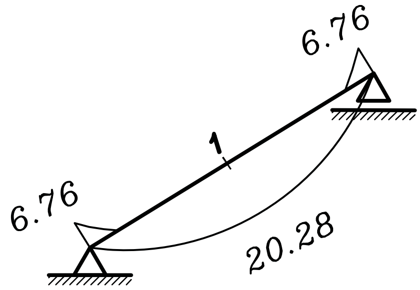


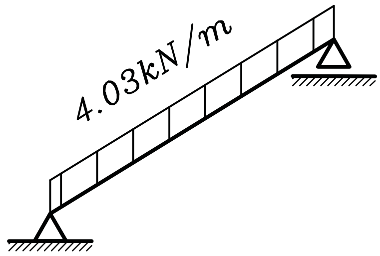
KEY PLAN
1:200 ⟶ 1:400



Side view

B.M.D.





<u>Sec. (1-1)</u>

$$220 = C_1 \sqrt{\frac{20.28*10^6}{500*25}} \qquad C_1 = 5.46 \qquad J = 0.826$$

$$A_s = \frac{20.28*10^6}{0.826*360*220} = 3.10 cm^2/rib$$

$$A_s = 2\Phi 16/rib$$

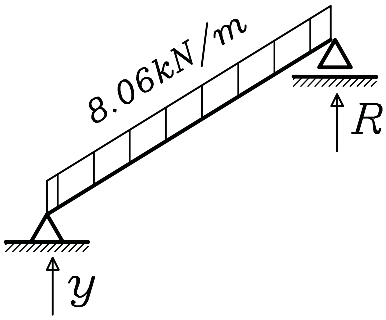
<u>Sec. (2-2)</u>

$$A_s = 2\Phi 10/rib$$

2]Reactions of slabs on beams

$$R = y = w_{su}\frac{L'}{2} \qquad kN/m$$

$$R = y = 8.06*6.71/2 = 27.04 \quad kN/m$$

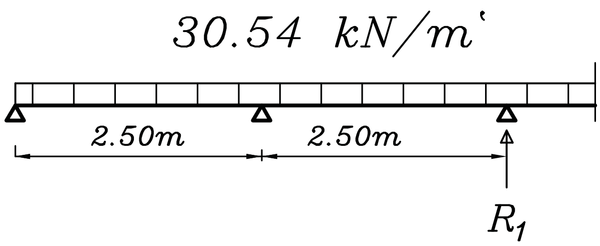


3]Analysis of Ridge beam(250*400)

$$w = R + o.w \qquad kN/m$$

$$w = 27.04 + 0.25*0.40*25*1.40$$

$$w = 30.54 \quad kN/m$$



$$R_1 = 30.54*2.5 = 76.35kN$$

4]Design of Posts

$$R_p = R_1 + o.w \text{ of Post}$$

5]Design of main system

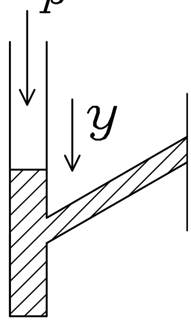
لاحظ فى هذه الحالة يكون (Frame) هو نفسه (Y–beam)

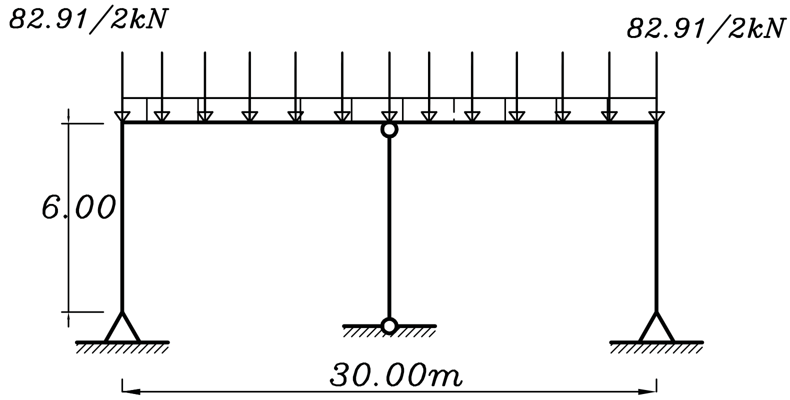
لان الشكل متماثل يمكن اعتبار العمود الاوسط Link member

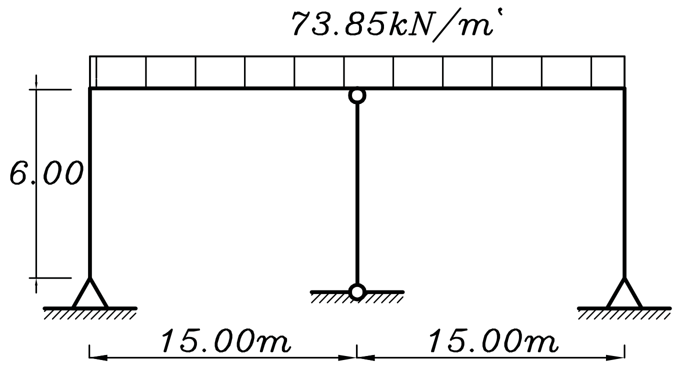
$$w_f = o.w. + y + \frac{\Sigma R_p}{Span} \quad kN/m$$

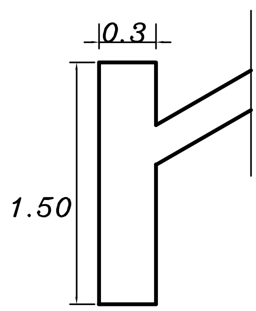
$$w_f = 0.30*1.30*25*1.40+27.04+\frac{12*82.91}{20.0}$$

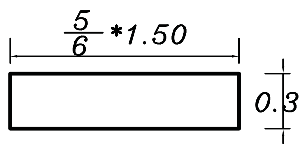
$$w_f = 73.85 kN/m$$











$$I_c = \frac{0.30*(\frac{5}{6}*1.30)^3}{12}$$

$$I_c = 0.032 m^4$$

$$I_b = 0.3*\frac{1.3^3}{12} = 0.055 m^4$$

For Joint a

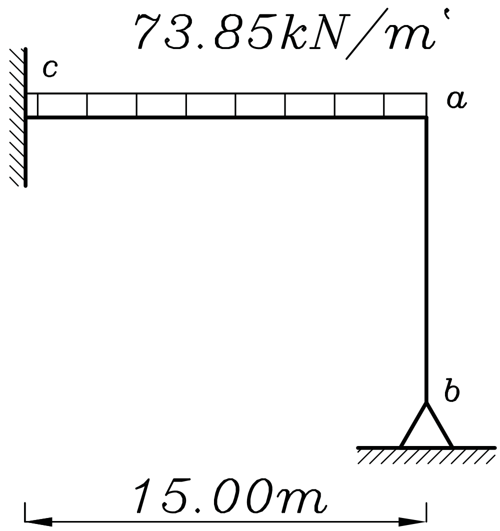
$$D.f_{ab} = \frac{0.75(\ I_c/h)}{(0.75\frac{I_c}{h})+(\frac{I_b}{L})}$$

$$D.f_{ab} = \frac{0.75*(0.032/6.00)}{0.75*(0.032/6.00)+(0.055/15)}$$

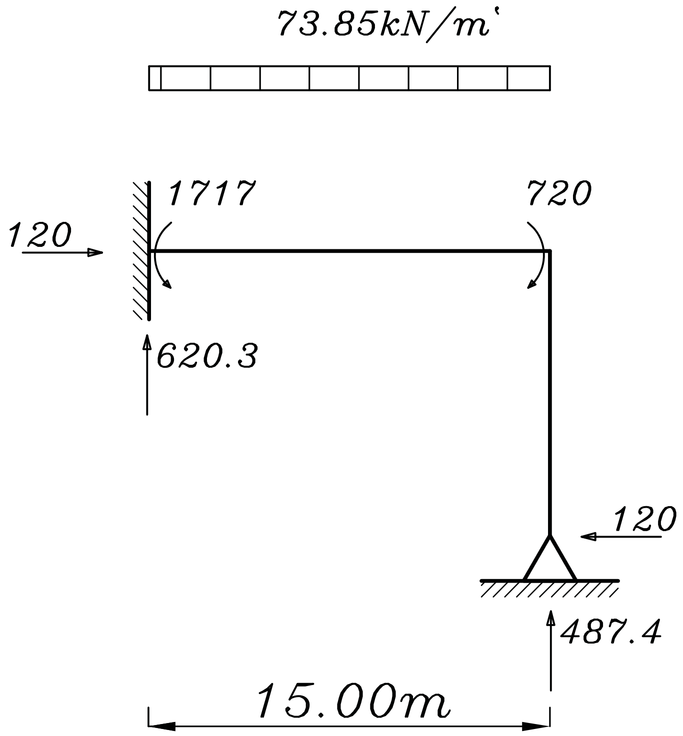
$D.f_{ab}=0.52$ $\quad$ $D.f_{ac}=1-0.52=0.48$

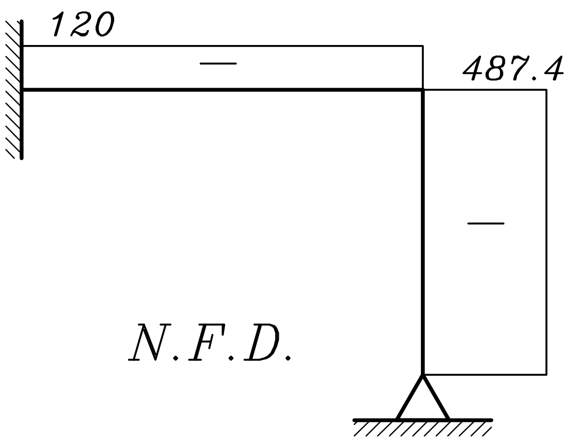
$F.E.M.=73.85*15^2/12=1384.7\ kN.m$

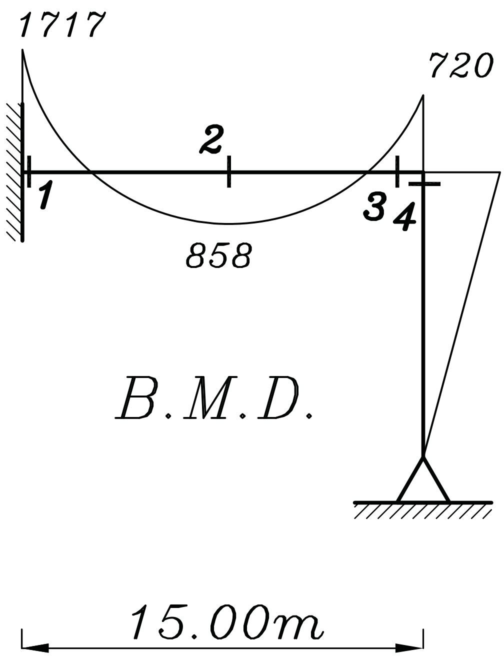
يحل نصف ال Frame لانه متماثل

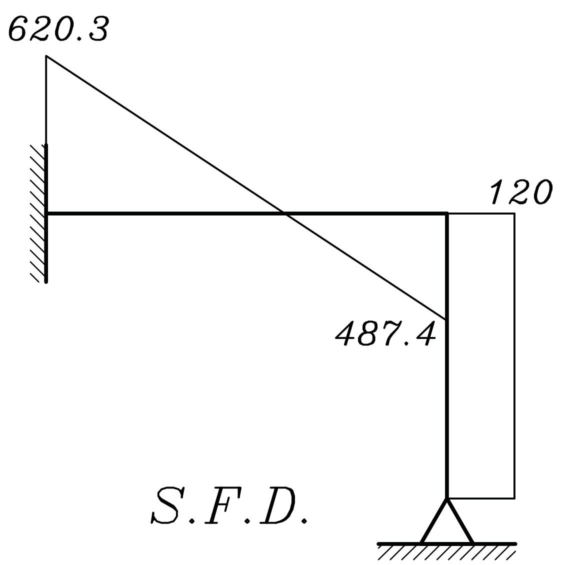


Joint	c	a	
member	ca	ac	ab
D.F.	—	0.48	0.52
F.E.M.	1384.7	−1384.7	0.0
Bal. M	0.0	664.7	720
C.O.M.	332.3	0.0	0.0
Bal. M	0.0	0.0	0.0
M_{final}	1717	−720	720


73.85kN/m'
1717
720
120
620.3
120
487.4
15.00m


120
—
487.4
—
N.F.D.

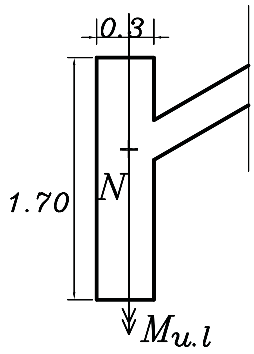

1717
720
2
1
3
4
858
B.M.D.
15.00m


620.3
120
487.4
S.F.D.

<u>Sec. (1-1)</u> $\quad M_{u.l.}=1717kN.m \quad\quad N_{u.l.}=120kN$

$b=300mm$, $\quad t=1300mm$

$$\frac{N_{u.l.}}{btf_{cu}}=\frac{120*10^3}{300*1300*25}=0.009<0.04 \quad (\text{ neglect } N_{u.l.})$$



$$d=C_1\sqrt{\frac{M_{u.l.}}{b*f_{cu}}}$$

$$1200=C_1\sqrt{\frac{1717*10^6}{300*32.5}} \qquad C_1=2.85 \quad \& \quad J=0.74$$

$$A_s=\frac{1717*10^6}{0.74*1200*360}$$

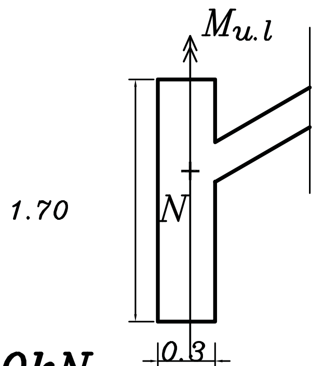
$$A_s=5371mm^2=11\phi25$$

<u>Sec. (2-2)</u> $\quad M_{u.l.}=858kN.m \quad\quad N_{u.l.}=120kN$ neglected

$$1200=C_1\sqrt{\frac{858*10^6}{300*32.5}} \qquad C_1=4.0 \quad \& \quad J=0.8$$

$$A_s=\frac{1924.06*10^6}{0.76*1600*360}$$

$$A_s=2483mm^2=7\phi22$$



<u>Sec. (3-3)</u> $\quad M_{u.l.}=720kN.m \quad\quad N_{u.l.}=120kN$ neglected

$$A_s=6\phi22$$

Sec. (4−4) $M_{u.l.} = 720 kN.m$ $N_{u.l.} = 487.4 kN$

$$\frac{N_{u.l.}}{btf_{cu}} = \frac{120*10^3}{300*1300*25} = 0.038 < 0.04 \text{ (neglect } N_{u.l.} \text{)}$$

$A_s = 6\phi 22$

Check Shear

$$Q_{cr} = Q_{max} - w\left(\frac{c}{2} + \frac{d}{2}\right)$$

$$Q_{cr} = 620.3 - 73.85\left(\frac{0.80}{2} + \frac{1.20}{2}\right)$$

$$Q_{cr} = 546.45 kN$$

$$q_{su} = \frac{Q_{cr}}{bd} = \frac{546.45*10^3}{300*1200} = 1.52 \ N/mm^2$$

$$q_{cu} = 0.24\sqrt{\frac{32.5}{1.5}} = 1.12 \ N/mm^2$$

$$q_{cu} < q_u < q_{umax}$$

$$q_{max} = 0.7\sqrt{\frac{32.5}{1.5}} = 3.25 \ N/mm^2$$

$$q_u - \frac{q_{cu}}{2} = \frac{nA_s f_y / \gamma_s}{bS}$$

assume $n = 2$ $A_s = 78.5 mm^2 = \phi 10$

$$1.52 - \frac{1.12}{2} = \frac{2*78.5*240/1.15}{300*S} \longrightarrow S = 113 mm$$

$$\text{No.of stirrups}/m' = \frac{1000}{S}$$

Take Stirrups $9\phi 10/m'$

Design of Internal column

$N_{u.l.} = 620.3*2 = 1240.6 kN$

$\lambda_{b_{in}} = \frac{1.3*5.45}{0.8} = 8.8$, $\lambda_{b_{out}} = \frac{1.2*6.25}{0.3} = 25$ unsafe

Take $b_{col} = 35 cm$

$\lambda_{b_{out}} = \frac{1.2*6.25}{0.35} = 21.4$

Column is Long outside plan.

$$\delta_b = \frac{\lambda_{b_{out}}^2 * b}{2000} = \frac{21.4^2*0.35}{2000} = 0.08 \text{ m}$$

$M_{add} = P.\delta_b = 1240.6*0.08 = 99 kN.m$

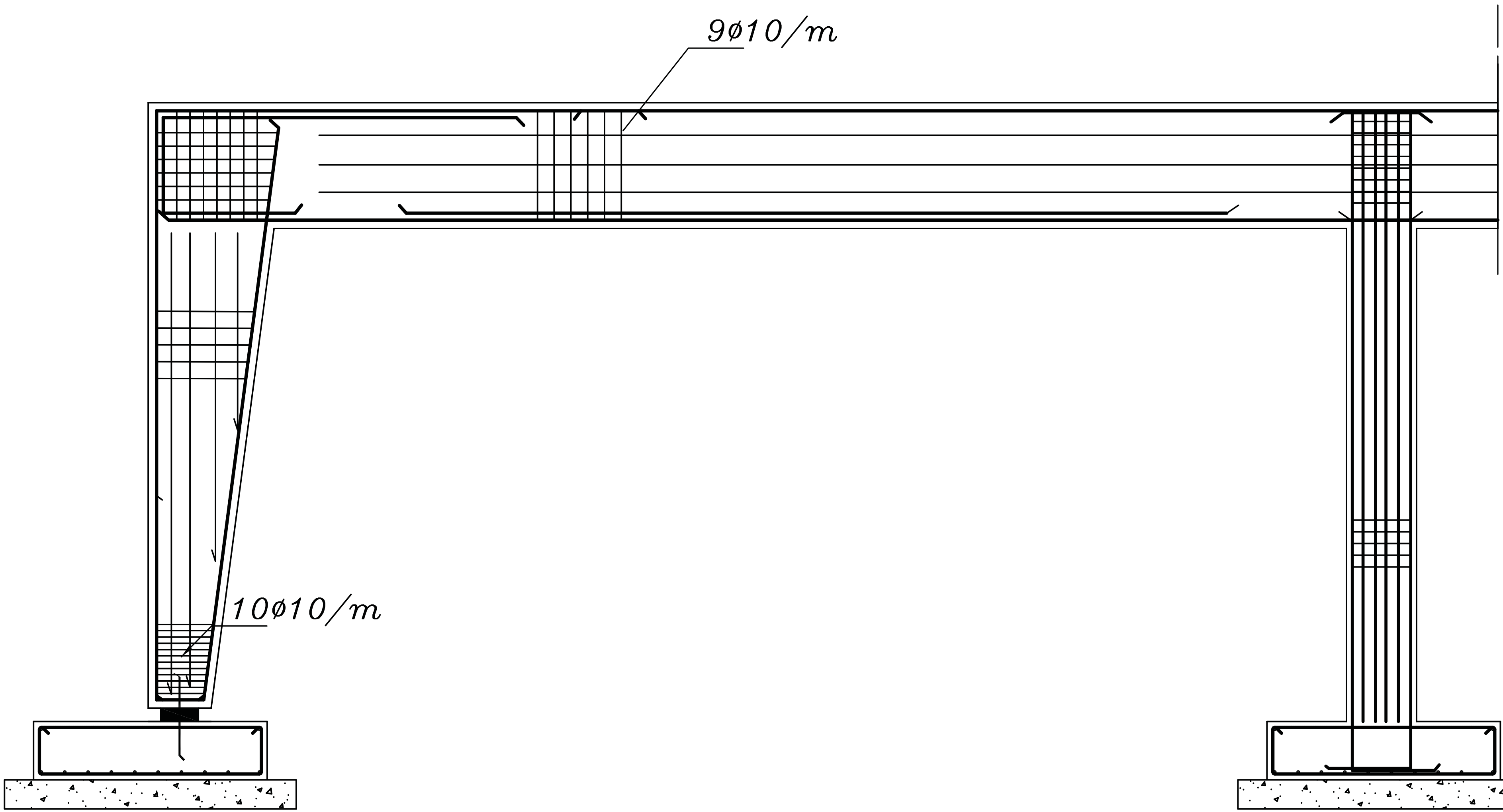
$$\frac{N_{u.l.}}{btf_{cu}} = \frac{1240.6*10^3}{350*800*32.5} = 0.136 \quad , \quad \frac{M_{u.l.}}{b^2tf_{cu}} = \frac{99*10^6}{350^2*800*32.5} = 0.03$$

$\rho < 1$ Take $\rho = 1$

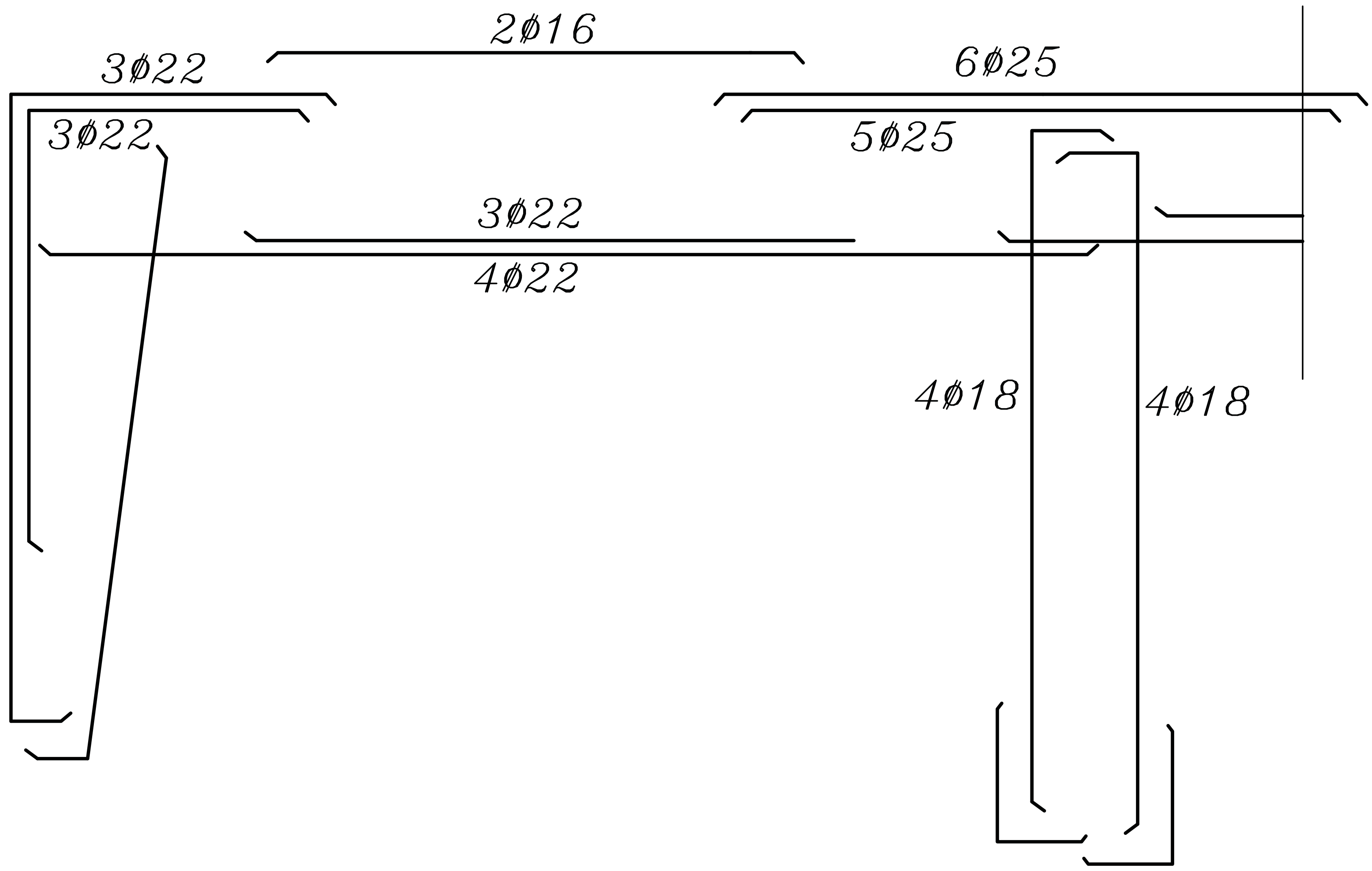
$$A_{smin} = \frac{0.25+0.052*21.4}{100} *350*800 = 3816 mm^2$$

$16 \phi 18$

R.F.T. of the Frame

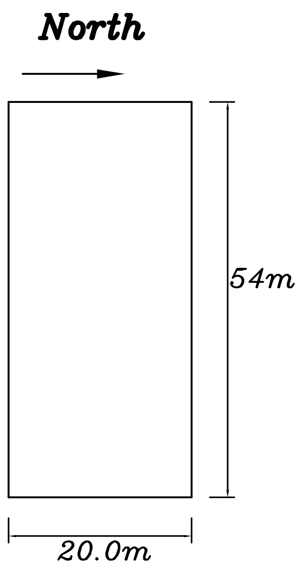


R.F.T. of the Frame



Example

For the given plan, it is required to:



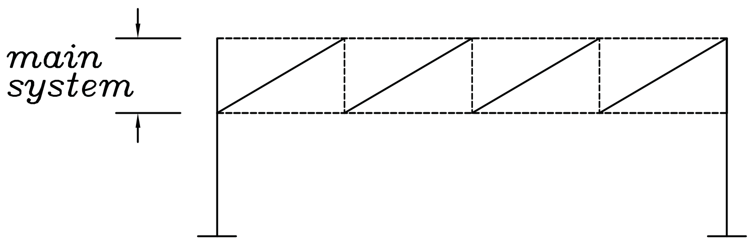
1-Choose the suitable system to cover this Area.

2-Design all Slabs and draw plan of Rft.

3-Design the main supporting element and draw details of Rft.

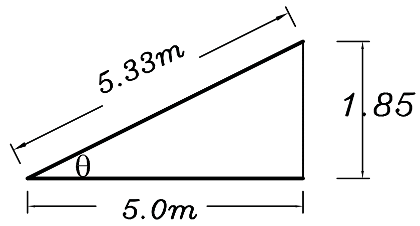
$F.C.=1.5 kN/m^2$,$L.L=0.5$ kN/m^2

$f_{cu}=25$ N/mm^2, $f_y=360$ N/mm^2

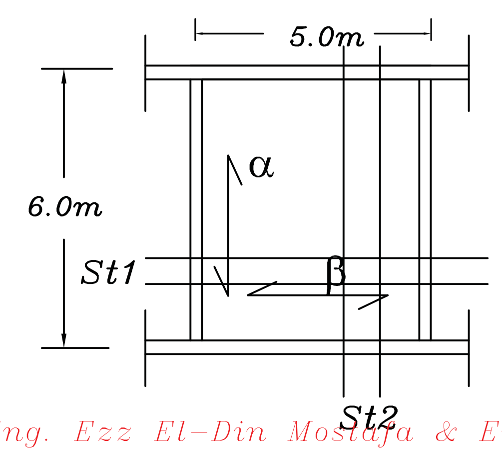


Columns are only allowed on perimeter

Two way slab لاحظ ان البلاطة تحل على انها



$$\theta=\tan^{-1}\left(\frac{1.85}{5.0}\right)=20.3$$

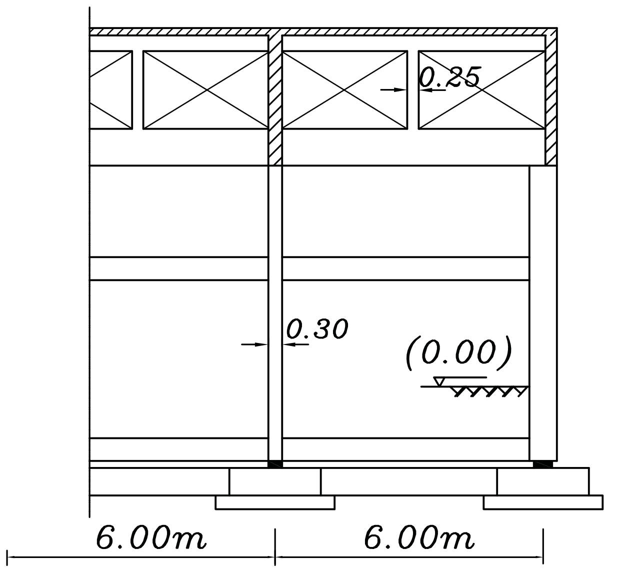


$$r=\frac{0.76*6.0}{5.33}=0.85$$

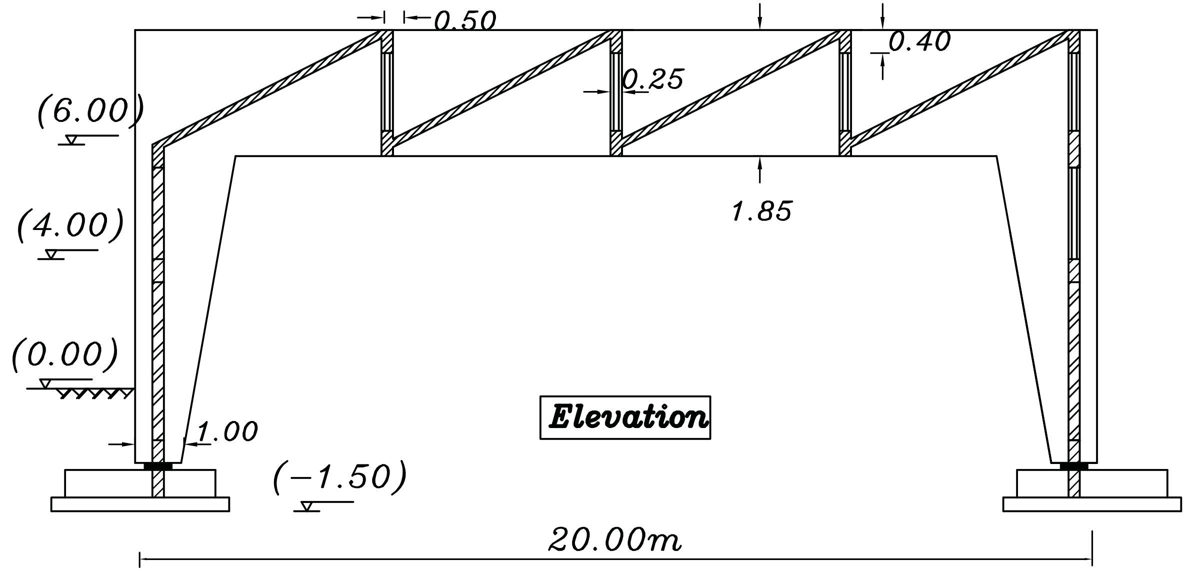
$$r^*=1.17$$

$$\alpha=0.43$$

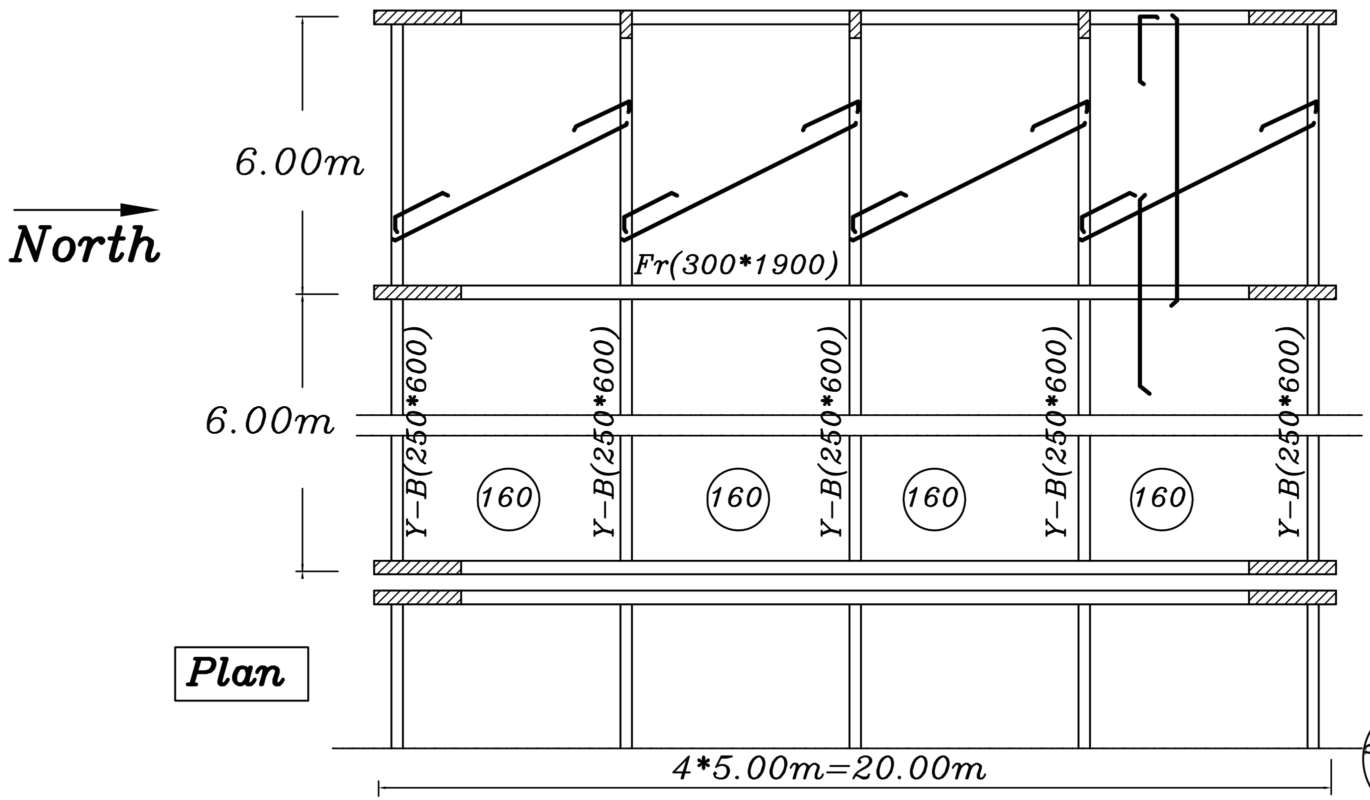
$$\beta=0.25$$



Side view

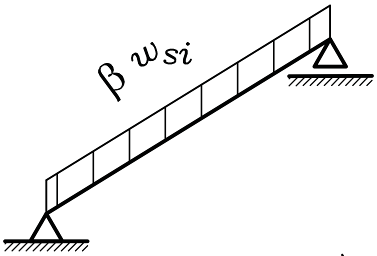


Elevation

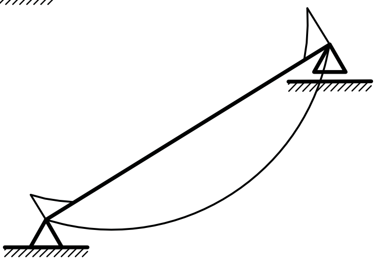


Plan

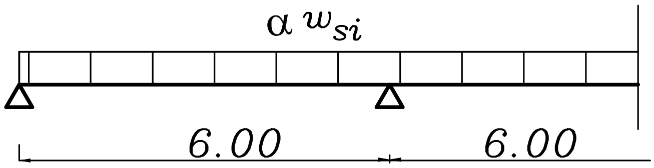
Strip 1

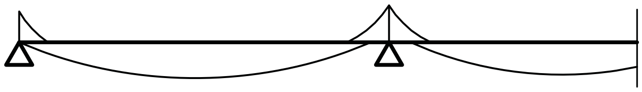


B.M.D.

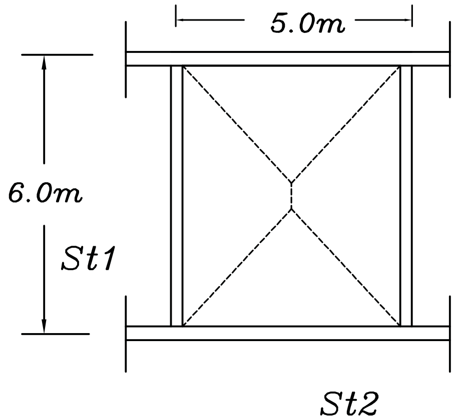


Strip 2





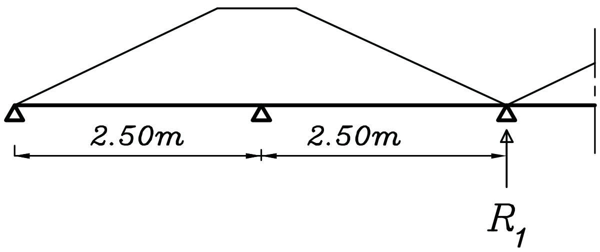
Load distribution

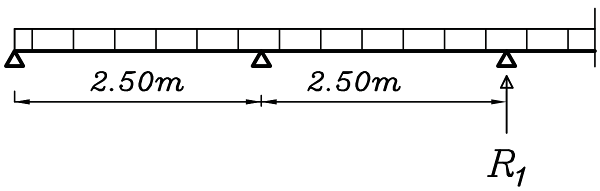


Analysis of Ridge beam(250*400)

$$w = o.w. \; + \frac{\Sigma\, Area}{Span}\, w_{si}$$

$$R_1 = w*2.5 = -----kN$$



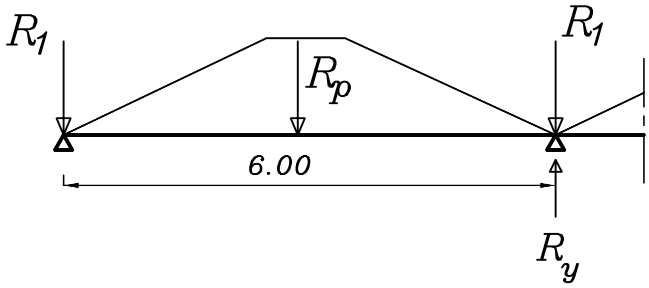


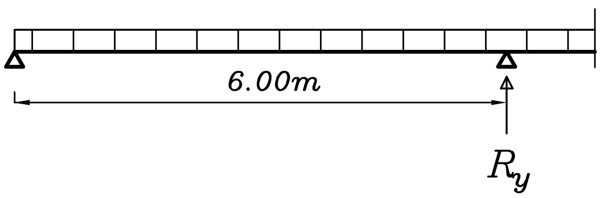
Design of Posts

$R_p = R_1 + o.w \text{ of Post}$

Analysis of Y–beam

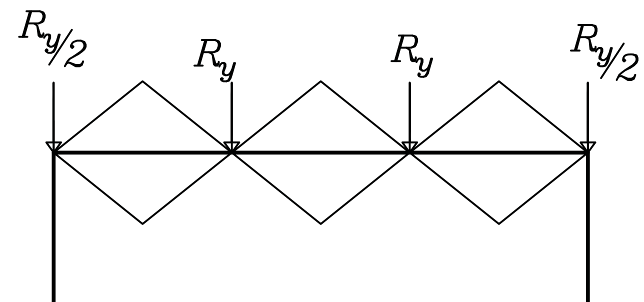
$$w = o.w. + \frac{\Sigma Area}{Span} w_{si} + \frac{R_1 + R_p}{Span}$$





$R_y = w * 6.0 = - - - - - kN$

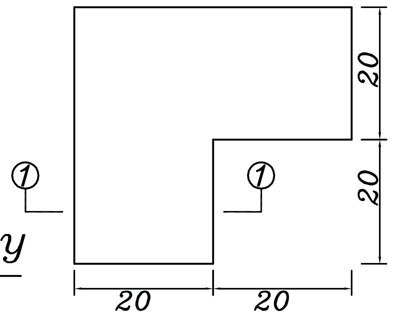
Analysis of Frame



ثم يتم تصميم الFrame كما سبق

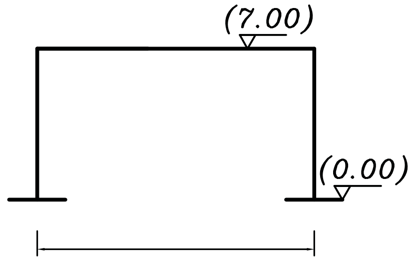
Example

For the given plan and cross– section,



Columns are allowed on the perimeter only

it is required to:



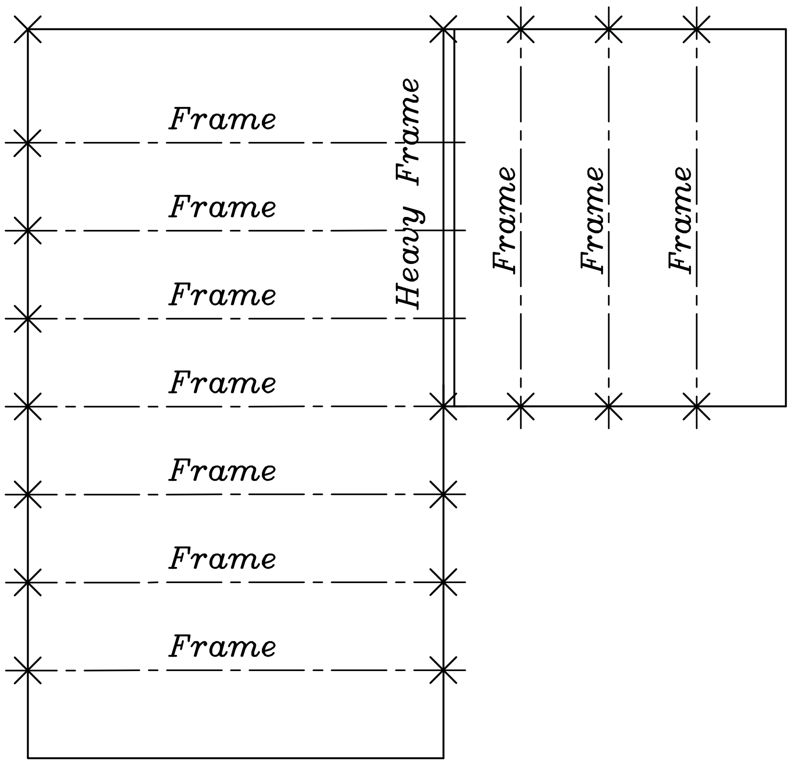
Sec.(1–1)

1– Draw structural plan and cross section to show all concrete elements.

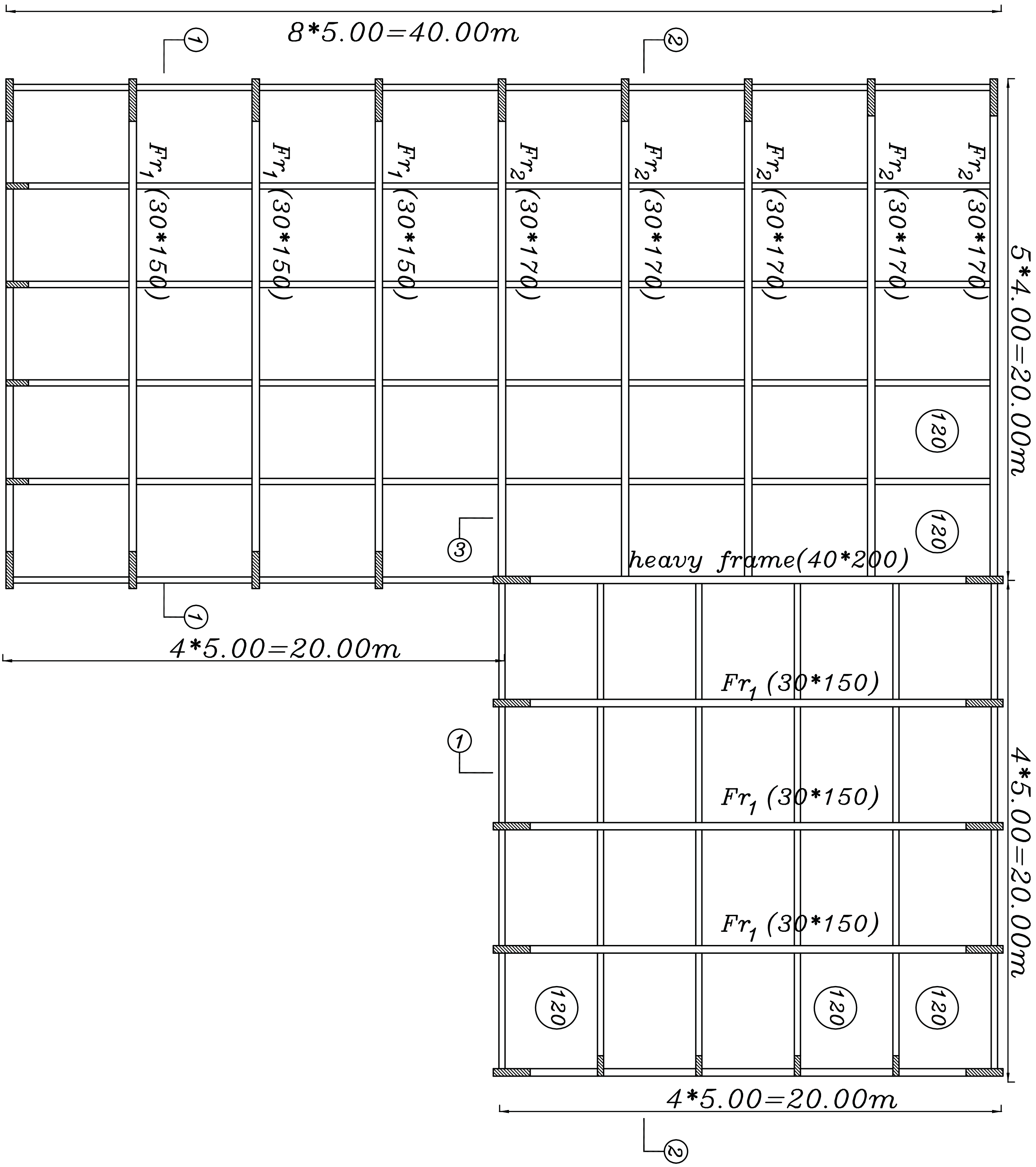
2– Show How to solve main systems

Solution

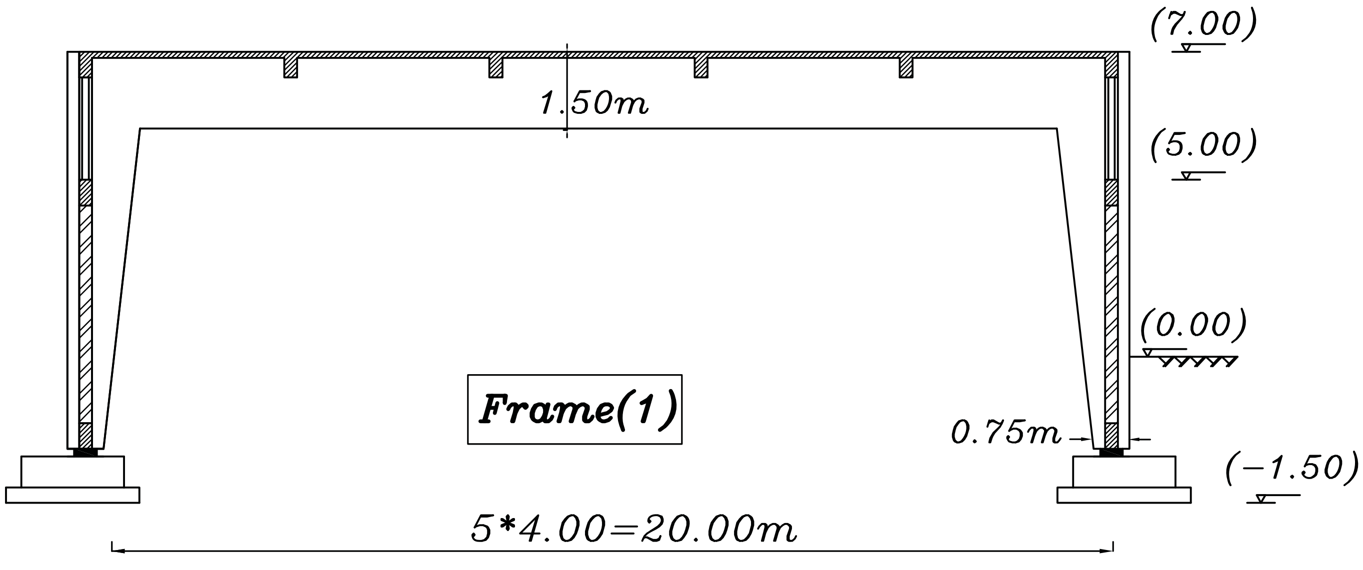
لاحظ ان الارض ليست مستطيلة



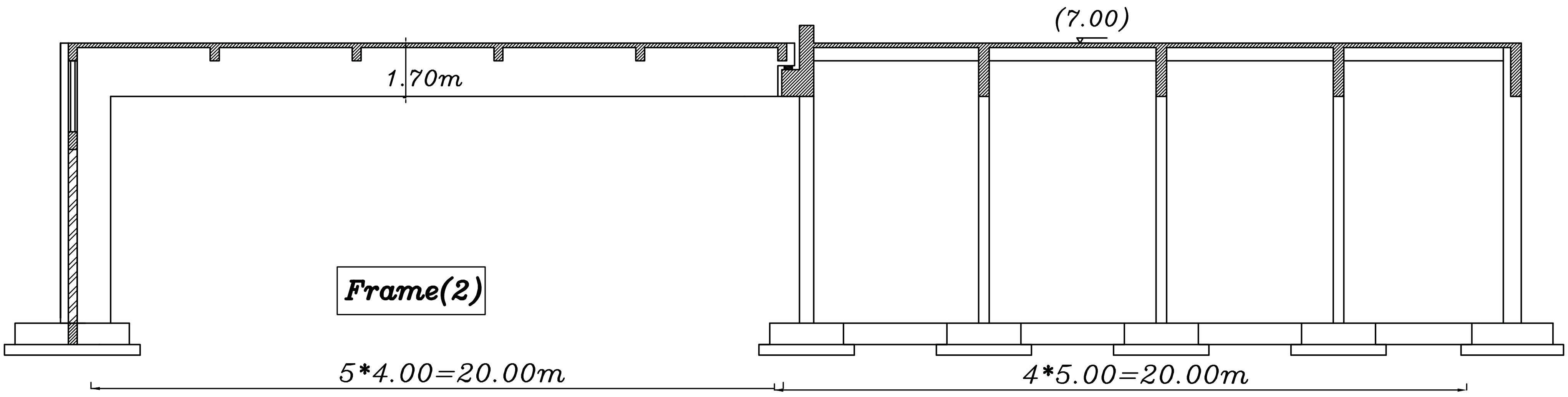
By Eng. Ezz El–Din Mostafa & Eng. Yasser M. Samir



By Eng. Ezz El-Din Mostafa & Eng. Yasser M. Samir

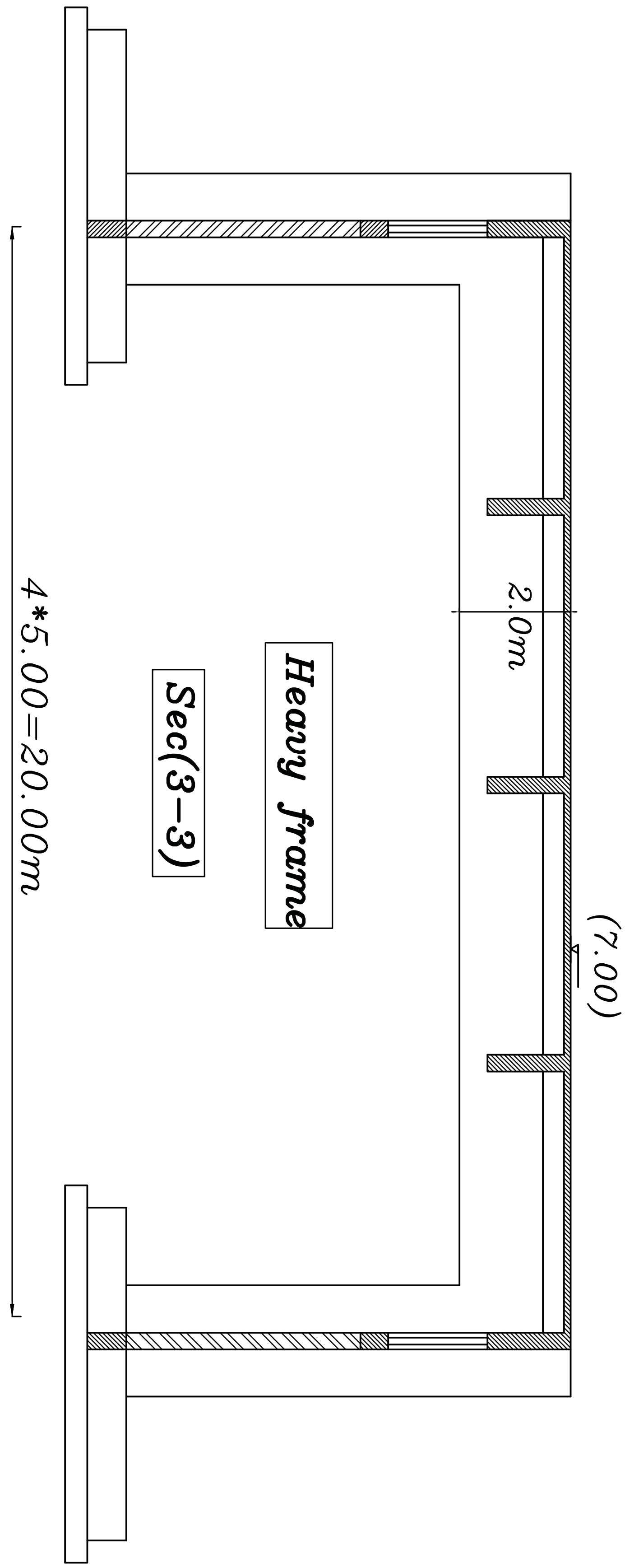


Sec(1-1)

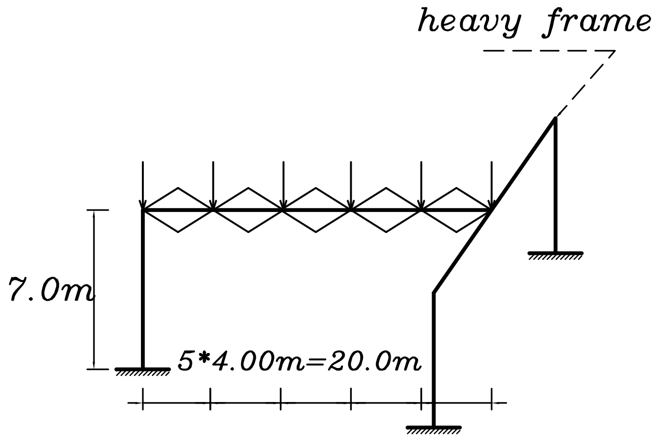


Sec(2-2)

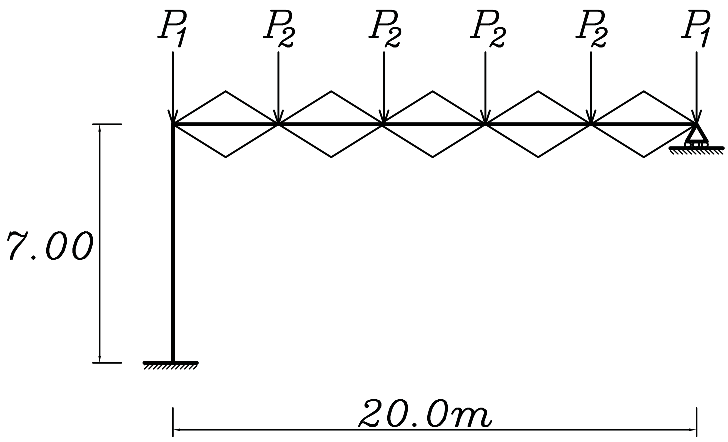
By Eng. Ezz El-Din Mostafa & Eng. Yasser M. Samir

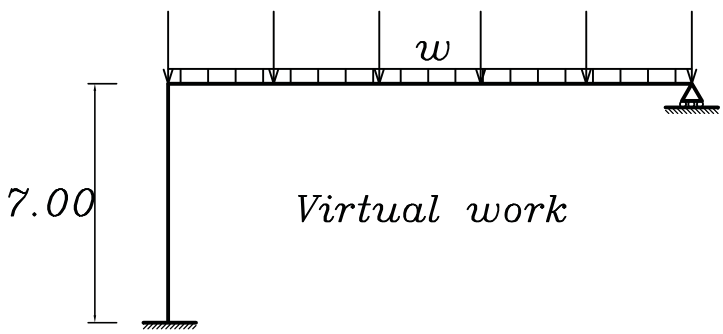

Heavy frame
Sec(3-3)
4*5.00=20.00m
2.0m
(7.00)

For Frame(2)

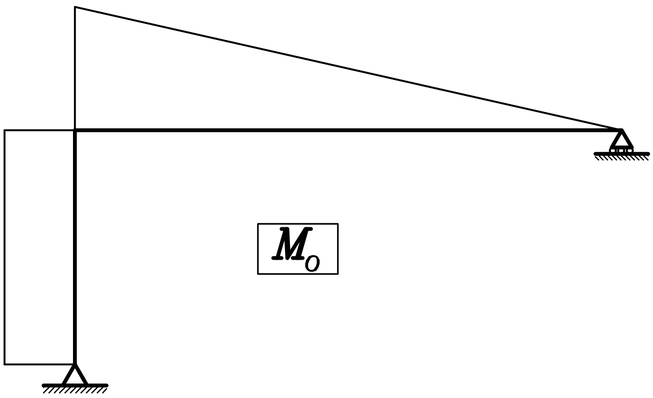


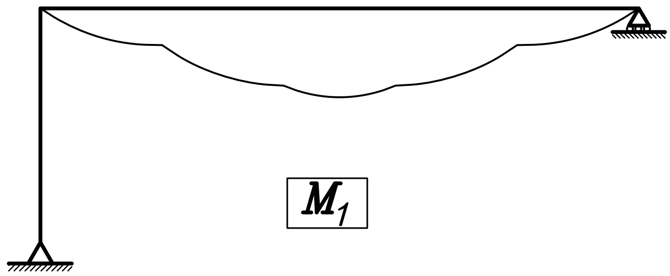
المفروض يتم حله فى الفراغ (Space frame) ولكن نظرا لصعوبة الحل يتم وضعه على (Neoprane plate) وبالتالى يصبح

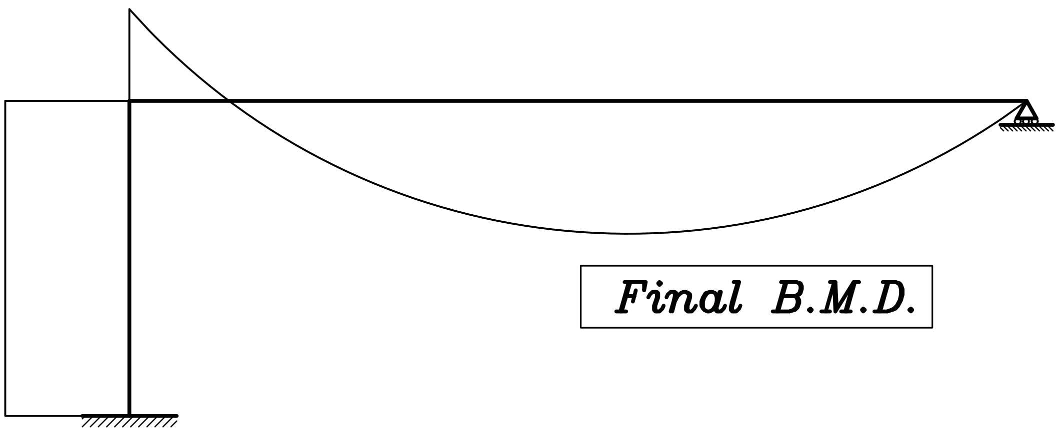


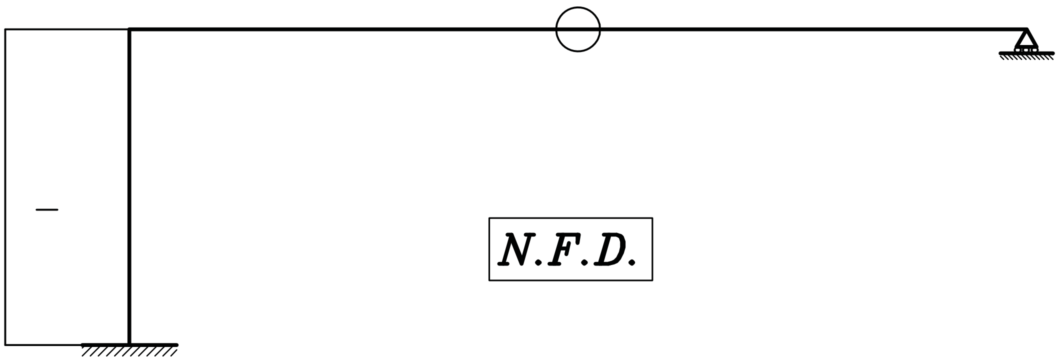


Solving using virtual work method

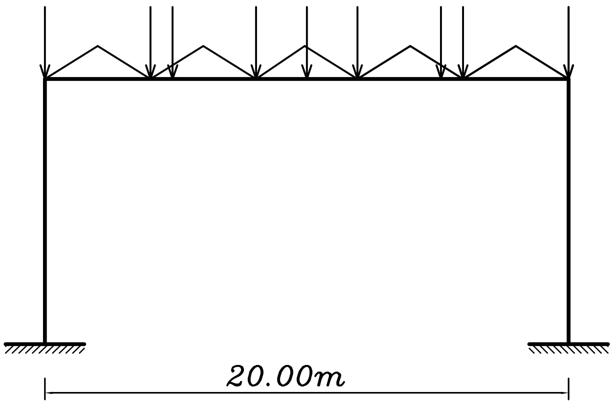








For heavy frame

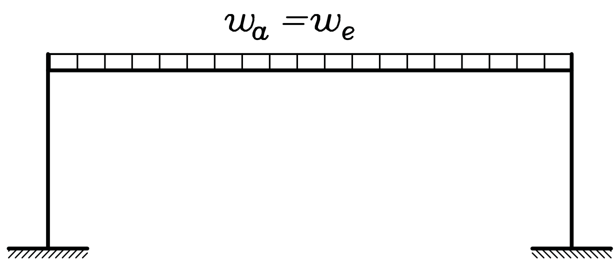


نتيجة لان (heavy frame) عليه أحمال ثقيلة فان

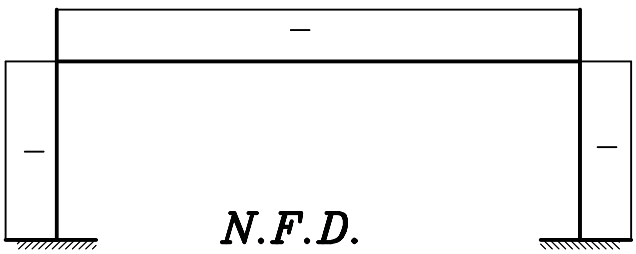
$$b = 40cm, \quad t = \frac{L}{10} = \frac{20}{10} = 2.00m$$

$$w_a = w_e = \gamma_c b(t - t_s) * 1.40 + \frac{\Sigma \, Area}{Span} w_s + \frac{\Sigma \, Concentrated \;\; loads}{Span}$$

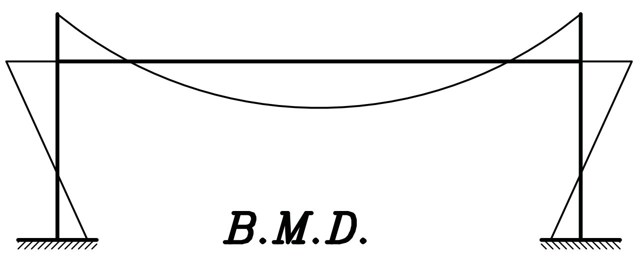
Where Concentrated loads are the loads from secondary Beams & Frames



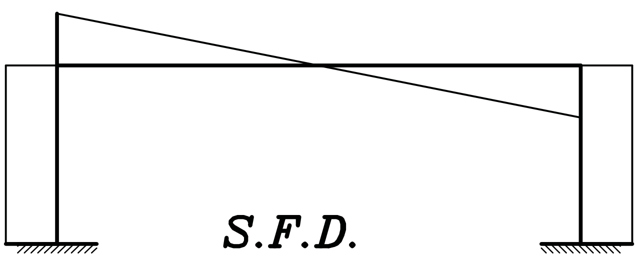
ثم نحله باستخدام (Moment Distribution)



N.F.D.



B.M.D.



S.F.D.